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April 30, 1990

Energy Research Abstracts

Abstracts 19159–21116

Office of Scientific and Technical Information
UNITED STATES DEPARTMENT OF ENERGY

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Energy Research Abstracts

Purpose

Energy Research Abstracts (ERA) provides abstracting and indexing coverage of all scientific and technical reports, journal articles, conference papers and proceedings, books, patents, theses, and monographs originated by the U.S. Department of Energy, its laboratories, energy centers and contractors. *ERA* also covers other energy information prepared *in report form* by federal and state government organizations, foreign governments, and domestic and foreign universities and research organizations. Foreign information is obtained through the International Energy Agency's 14-nation Energy Technology Data Exchange, the International Atomic Energy Agency's International Nuclear Information System, or nation-to-nation agreements. **Please note that *ERA* coverage of nonreport literature is limited to that generated by Department of Energy activity.**

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ERA is comprehensive in its subject scope, encompassing DOE's research, development, demonstration, and technological programs resulting from its broad charter for energy sources, supplies, safety, environmental impacts, and regulation.

The citations presented in *ERA* are available for on-line searching as records within the Energy Data Base. The current-year records are available on the Integrated Technical Information System (ITIS). The entire data base is available through commercial on-line vendors.

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ERA is available to the public on a subscription basis from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. The subscription rate for 24 semimonthly issues is $184.00 for domestic subscribers and $230.00 for foreign subscribers. A single issue costs $27.00, domestic, or $33.75, foreign. Cumulative indexes are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Managing Editor, Audrey B. Smith
Technical Editor, M. Catherine Grissom

Information Sources

The citations presented in *Energy Research Abstracts* are a subset of the worldwide energy information provided to the Office of Scientific and Technical Information (OSTI) through exchange agreements with foreign sources and through exchanges or contracts with U.S. organizations.

The **Energy Technology Data Exchange (ETDE)** was established by the International Energy Agency to promote cooperation among members in conducting appropriate energy-related research and development programs through the development of a formal central information sharing system. In accomplishing the objectives of the ETDE, members select, abstract, and index relevant research information published in their countries in accordance with Exchange standards. OSTI serves as the central receiving and processing center for this information, which it then disseminates to national centers in the participating countries. The following countries are currently members of the ETDE:

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The **International Nuclear Information System (INIS)** was established to promote the exchange of information on nuclear science and technology. Its operation is similar to that of the ETDE, with the INIS Secretariat being located in Vienna, Austria. Currently, 75 countries and 14 international organizations are members of INIS. OSTI serves as the INIS national center for the United States.

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3. **Title and subtitle** (non-English title may appear in parentheses, if applicable).
4. **Author(s).** First 10 names in the data record are printed, then "et al." is listed.
5. **Author affiliation.** Only first one is listed, in parentheses after author(s) to which it applies.
6. **Collaboration,** if present.
7. **Corporate author(s)** identifying corporation responsible for document.
8. **Patent assignee and number** for citations of patent documents or applications.
9. **Journal title, volume, and issue** for citations of journal articles.
10. **Date of publication.** If not known, a processing date is in brackets.
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14. **Publisher's name and location** for documents published by a corporate or commercial source.
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16. **Contract or grant number.**
17. **Secondary identifying number;** may be a conference number.
18. **Conference title, location, and date,** if applicable.
19. **Order number.** The "DE" order number may be used for ordering from NTIS or OSTI, as appropriate. The "TI" prefix is valid only at OSTI.
20. **Sources of availability** from which a copy of the document may be obtained; usually appear as abbreviations. (See information on following page.)
21. **Drop note** or explanatory statement.
22. **Abstract.**
23. **Subject descriptors.** Listed only if no abstract or only a brief statement is included.

Sample Citations

Report

1849 (DOE/ER/40438–T1) **[Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report.** Haeberli, W. Phys. VI collaboration. Wisconsin Univ., Madison (USA). Dept. of Physics. [1989]. 12p. Sponsored by DOE Energy Research. DOE Contract FG02-88ER40438. Order Number DE89007246. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper briefly discusses the Wisconsin test facility for storage cells; results of target tests; the new UHV...

Report Analytic

18500 (INIS-SU—69, pp. 30-32) **Transition energies in Ne-like ions. Correlation effects.** Vainshtejn, L.A. AN SSSR, Moscow. Fizicheskij Inst. 1988. (In Russian). In *Experimental and theoretical physics. Collection.* Order Number DE89780060. Available from NTIS (US Sales Only), PC A03/MF A01; INIS.

Kratkie Soobshcheniya po Fizike.; no. 6.

SILVER IONS/energy-level transitions; XENON IONS/energy-level transitions; CORRELATIONS; D STATES; E STATES;...

Journal Article

19055 **A theoretical and experimental investigation of long-pulse, electron-beam-produced rare gas plasmas.** Brake, M.L.; Repetti, T.E. (Energy Beam Interaction Lab. of the Dept. of Nuclear Engineering, Univ. of Michigan, Ann Arbor, MI (US)). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Plasma Science (USA),* 16(5): 581-589 (Oct 1988). (CONF-881020–: Symposium on radiation physics, Sao Paulo, Brazil, October 3, 1988).

Visible emission spectroscopy (380-650 nm) has been performed on intense, electron beam (1 kA, 300 ns, 300 kV) produced Ar, Kr,...

Patent

18045 **Polarization of fast particle beams by collisional pumping.** Stearns, J.W. To Dept. of Energy, Washington, DC. USA Patent 4,724,117. 9 Feb 1988. Filed date 19 Oct 1984. vp. Available from Patent and Trademark Office, Box 9, Washington, DC 20232.

A method for polarizing a fast beam of particles by collisional pumping, comprising the steps of generating a beam...

How To Order from the Availability Sources

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Report literature, usually identified by an alphanumeric identifier at the beginning of a citation, is available from the sources listed in the citation (see example of element 20 on page iii). Often the sources are listed as abbreviations. Corresponding addresses are provided at right from which documents with these abbreviations may be ordered. When "OSTI" is given, **DOE and DOE contractors may order these documents from OSTI.** (However, check with your library or information organization which may require that orders go through them to OSTI.) The public should order from NTIS or from one of the other agencies listed in the citation. To expedite processing, an order form is provided in the back of this publication. NOTE: The order numbers provide quicker access for report ordering. Use the order number where possible.

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United Kingdom

How To Use the Indexes

Five indexes are provided for approaching the content of each issue of *Energy Research Abstracts.* Descriptions of entries in these indexes follow.

Corporate Author Index
The corporation, organization, or institution responsible for the issuance of the document is listed in this index. The entries are arranged alphabetically and provide the title and citation number of the reference. For example, the listing for the "Report" sample citation would appear as shown at right.

Wisconsin Univ., Madison (USA). Dept. of Physics
[Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report, 15:18494 (R;US)
Wisconsin Univ., Madison (USA). Lab. of Genetics
Organization of the R chromosome region in maize: Final progress report, June 1, 1983–May 31, 1986, 15:18255 (R;US)

Personal Author Index
Each author's name listed on a document cited in this issue is indexed. An index entry provides title and citation number; for secondary and other names, a cross-reference is given to the primary author name where the full index entry is located.

Hadley, D.L., *See* Lee, A.D., 15:17651
Haeberli, W., [Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report, 15:18494 (R;US)

Subject Index
This index lists the main subject descriptors assigned to each record by indexing professionals. A secondary or qualifier term is used where necessary to describe materials, objects, and processes. Document titles may be enhanced with additional informative phrases where necessary. An excerpt from this index appears at right.

HYDROGEN ISOTOPES
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Neutron-Rich Isotopes
Study on the strong neutron-rich nuclei of lightest elements, 15:18686 (RA;SU;In Russian)

Contract Number Index
DOE technical reports are listed by contract number. Each entry also provides the primary corporation or organization cited for that contract number. A typical entry is shown.

FG02-88ER40438 **Wisconsin Univ., Madison (USA). Dept. of Physics**
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FG02-88ER60664 **Rogers and Associates Engineering Corp., Salt Lake City, UT (USA)**
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Report Number Index
Technical report literature is indexed by the alphanumerical identifier of the report. Patent documents and conferences are included for convenience. Each entry lists the citation number, the source of availability of the document, an indicator of presence at a GPO depository library, order number, and distribution category. A typical entry is:

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The subject content of *Energy Research Abstracts* is arranged as shown below. The two-digit and four-digit category numbers printed here illustrate the category number assignment used in the data base records.* The following list includes all of the 39 first-level and the 308 second-level categories. Because each issue of *ERA* publishes citations only for those documents announced during the past semimonthly period, some subject categories may not be present in every issue.

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*The numerical subject category scheme is used in the storage, retrieval, and manipulation of bibliographic information entered into DOE's data systems. Categories and definitions for the complete set of six-digit numbers are given in DOE/TIC-4584, *Energy Data Base: Subject Categories and Scope.*

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Energy Research Abstracts

01 COAL, LIGNITE, AND PEAT

Refer also to citation(s) 20432

19159 (CONF-891185–) **The Asia-Pacific coal technology conference.** East-West Center, Honolulu, HI (USA). Resource Systems Inst.; USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Feb 1990. 446p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG03-89FE61811. From Asia-Pacific coal technology conference; Honolulu, HI (USA); 14-16 Nov 1989. Order Number DE90006339. Available from NTIS, PC A19/MF A01 - OSTI.

The Asia-Pacific coal technology conference was held in Honolulu, Hawaii, November 14–16, 1989. Topics discussed included the following: Expanded Horizons for US Coal Technology and Coal Trade; Future Coal-Fired Generation and Capacity Requirements of the Philippines; Taiwan Presentation; Korean Presentation; Hong Kong Future Coal Requirements; Indonesian Presentation; Electric Power System in Thailand; Coal in Malaysia – A Position Paper; The US and Asia: Pacific Partners in Coal and Coal Technology; US Coal Production and Export; US Clean Coal Technologies; Developments in Coal Transport and Utilization; Alternative/Innovative Transport; Electricity Generation in Asia and the Pacific: Power Sector Demand for Coal, Oil and Natural Gas; Role of Clean Coal Technology in the Energy Future of the World; Global Climate Change: A Fossil Energy Perspective; Speaker: The Role of Coal in Meeting Hawaii's Power Needs; and Workshops on Critical Issues Associated with Coal Usage. Individual topics are processed separately for the data bases.

0103 Preparation

Refer also to citation(s) 19173, 19229

19160 (EUR–12315-DE) **Investigation of machine engineering and process engineering methods of improving the dewatering of fine and very fine grained hard coal product.** Lotzien, R.; Erdmann, W.; Jung, R. Bergbau-Forschung GmbH, Essen (Germany, F.R.). 1989. 94p. (In German). Available from Commission of the European Communities, Luxembourg.

Late in 1987 a continuous pressure disk filter of 60 m^2 filtering surface was commissioned at Prosper II colliery for the dewatering of flotation concentrate. The filter consists of 5 disks mounted to one control head. The filter cake is discharged through a twofold gate. The pressure filter functions with good availability; improvements were made above all to the cake detaching and discharge system. The filter operates in a range of ΔP 1.0 to 3.0 bar and at n 0.5 to 2.5 filter disk rotation. Its throughput is, inter alia, a function of the above parameters. It was evidenced that Darcy's theoretical filter equation applies to this raw material as well. Practical studies were accompanied by extensive tests both on a laboratory as well as on a technical scale using novel-type filtering media for vacuum or pressure filtration. Said filtering media provide a high initial capillary pressure to prevent the breakthrough of air and thus noticeably reduce air consumption as against conventional filtration. The results obtained under properly selected operational conditions are comparable to those yielded by conventional pressure filtration. Filtration tests on flotation concentrates in discontinuous filter presses have resulted in minimal residual moisture in the filter cake provided the blowing pressure for predrying the feed material is adequate. Due to the relatively poor compression of granular feed material, diaphragm compression did not turn out to be purposeful. Dewatering of coarsely disperse solids of a grain size between 3 and 0.5 mm in centrifuges running at centrifuge numbers beyond z 200 has shown that any comminution of the material may severely hamper dewatering. 21 refs., 53 figs., 19 tabs.

19161 (NERDDP-EG–89-804) **Microwave drying and heating of coal.** Worner, H.K. National Energy Research, Development and Demonstration Council, Canberra (Australia). 1989. vp. Available from Department of Resources and Energy, GPO Box 858, Canberra, ACT 2601, Australia.

The objective of this project was to investigate the possible benefits of using microwave energy at a frequency of 2450 MHz as a practical and commercial means of partially drying Australian coals and coal-mineral composites prior to shipment or processing, and to design an appropriate materials handling system for the task. The study found that Australian coals are too variable in response to microwave heating to be suitable for microwave drying using a conveyor belt method. The project also found that static bed drying and conveyor drying methods, using microwaves, were much less efficient than rotary methods, where the coal was tumbled in the microwave field.

19162 **Selective flotation of inorganic sulfides from coal.** Miller, K.J.; Wen, W.W. To Dept. of Energy, Washington, DC. USA Patent 4,867,868. 19 Sep 1989. Filed date 31 May 1988. USA Patent Application 7 200,100. Int. Cl. B03D 1/02. 6p. Available from Patent and Trademark Office, Box 9, Washington, DC 20232.

This patent describes a method in which pyritic sulfur is removed from coal or other carbonaceous material through the use of humic acid as a coal flotation depressant. Following the removal of coarse pyrite, the carbonaceous material is blended with humic acid, a pyrite flotation collector and a frothing agent within a flotation cell to selectively float pyritic sulfur leaving clean coal as an underflow.

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Refer also to citation(s) 19193, 19199, 19203, 19229, 19538, 19846, 19932, 20828

19163 (ANL/FE–89/6) **Development of oxide-dispersion-strengthened alloys for fossil energy applications.** Natesan, K. Argonne National Lab., IL (USA). Oct 1989. 22p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-31109-ENG-38. Order Number DE90006475. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Iron-based alloys containing chromium, nickel, aluminum, and rare- earth metals or oxides have been developed by mechanical alloying for application in fossil energy systems. The presence of aluminum and nickel leads to precipitation of the Ni_3Al phase, which can improve the mechanical properties of the alloys. The addition of ≈4 wt.% Al to the alloy leads to formation of alumina scales when the alloys are exposed to oxidizing environment. A detailed description of the procedures for mechanical alloying is presented, and physical corrosion tests conducted in air and in sulfur-containing atmospheres, and in the presence of deposits of interest in fossil energy systems. 10 refs., 12 figs., 3 tabs.

19164 (CONF-890573–1) **Gasification of a low-rank coal.** Goyal, A.; Bryan, B.; Rehmat, A. Institute of Gas Technology, Chicago, IL (USA). [1989]. 18p. Sponsored by Institute of Gas Technology. Contract GRI 5084-221-1440. From 15. annual biennial low-rank fuels symposium; St. Paul, MN (USA); 22-25 May 1989. Available from OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616.

A high-pressure process development unit (PDU) was constructed by the Institute of Gas Technology (IGT) to develop a data base for the fluidized-bed gasification of different coals at elevated pressures. It has been operated with different ranks of coal at pressures up to 450 psig and at temperatures dictated by gasification requirements of the individual coals. Sufficient data have been obtained from this PDU to characterize the effect of pressure on the gasification of Montana Rosebud subbituminous coal and North Dakota lignite. The results obtained with North Dakota lignite are presented here. This program was funded by the Gas Research Institute. 8 refs., 8 figs., 2 tabs.

19165 (CONF-890668–1) **Recent developments in gasification of low-grade fuels.** Patel, J.G.; Mensinger, M.C. Institute of Gas Technology, Chicago, IL (USA). [1989]. 76p. Sponsored by Institute of Gas Technology. From Symposium on low-grade fuels; Helsinki (Finland); 12-16 Jun 1989. Available from OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616.

The decade of the 1980's has been a disappointing one for the synthetic fuels industry. However, from the immense efforts expended in developing various technologies, gasification has been the most successful. Several demonstration and commercial projects have been technically successful, and a few even continue to operate economically. Two areas of promising near-term potential for gasification are generation of electric power by integrated gasification combined cycle (IGCC) and production of high-value chemicals. In the USA, the Department of Energy's Clean Coal Technology Program is moving forward and should demonstrate a few of the newer coal gasification processes. In Europe, the fallout from Chernobyl is encouraging serious consideration of coal-based IGCC power plants, and in Japan, groundwork is being laid by continuing research and development to improve several technologies. This paper examines the latest status of some of the larger projects in gasification of coal, low-grade fuels, and biomass. 40 refs., 26 figs., 9 tabs.

19166 (CONF-890902–26) **Modeling of a coal carbonizer.** Rehmat, A. (Institute of Gas Technology, Chicago, IL (USA)); Goyal, A.; Van Hook, J.; Rovertson, A. Institute of Gas Technology, Chicago, IL (USA). 1989. 15p. Sponsored by Institute of Gas Technology. From 198. American Chemical Society national meeting; Miami, FL (USA); 10-15 Sep 1989. Available from OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616.

A computer model has been developed, using data currently available in the literature, to simulate air-blown pyrolysis of coal in a carbonizer. A sorbent (limestone or dolomite) can also be added to the carbonizer to capture in-situ sulfur released into the gas. The sorbent, besides reacting with sulfur, also influences the product yields by cracking some tar to gases and soot, and hence like temperature and pressure, forms an independent parameter of the system. The char, soot, tar, spent sorbent, sulfur capture, air feed, and product gas flow rates and their compositions are determined by the computer model. This model has been used to predict carbonizer performance for Pittsburgh No. 8 bituminous coal at different operating conditions. 18 refs., 8 figs., 2 tabs.

19167 (CONF-900391–4) **A process to produce medium-Btu gas from coal.** Knight, R.A.; Feldkirchner, H.L.; Carty, R.H.; Babu, S.P. Institute of Gas Technology, Chicago, IL (USA). [1990]. 17p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-84MC21203. From 1990 American Institute of Chemical Engineers (AIChE) spring meeting; Orlando, FL (USA); 18-22 Mar 1990. Order Number DE90007584. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Institute of Gas Technology (IGT) has conducted a fundamental research program to determine the technical feasibility of a process concept that involves pressurized CO_2-coal gasification followed by a high-temperature CO_2 removal step, using a MgO-based sorbent. To investigate a hot-CO_2-removal process, various MgO-containing materials were tested for their reactivity and capacity for removing CO_2 from hot gas streams in a high-pressure thermobalance. No naturally-occurring materials were found to be acceptable, but a KOH-promoted magnesia was found to be sufficiently active for CO_2 removal and to have a good capacity for CO_2 absorption. Tests were conducted at pressures and temperatures in the ranges of 100–300 psig and 850°–1170°F. The CO_2 absorption/desorption cycle was shown to be achievable by a simple pressure-swing operation between 0 and 315 psi CO_2 partial pressure. 4 refs., 8 figs., 2 tabs.

19168 (CONF-900403–5) **Corrosion performance of high-chromium weldments in simulated medium-Btu coal gasifier atmospheres.** Wang, D.Y.; Natesan, K. Argonne National Lab., IL (USA). Oct 1989. 19p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-31109-ENG-38. From Corrosion '90; Las Vegas, NV (USA); 23-27 Apr 1990. Order Number DE90005639. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Metallic components in coal gasification systems are exposed to severe corrosive environments containing oxygen and sulfur. Metallurgical coating is an economical and practical solution to material degradation problems created by such environments. Various studies indicate that chromized coatings provide the best protection against corrosion. However, in practical systems, weldments are used for joining and field repair of coated components, and the compatibility of the filler materials in the weldment with the hostile gaseous environments becomes the critical issue in overall corrosion performance in coal gasifier atmospheres. In this study, several commercial high-chromium filler materials containing various amounts of nickel were evaluated in a simulated medium-Btu coal gasifier atmosphere. The compatibility of the filler materials with the chromized Cr-Mo steels, and the influence of nickel and other solute elements on the corrosion behavior of weldments are addressed. 9 refs., 8 figs., 2 tabs.

19169 (CRIE-W–88002) **Study on simultaneous hot gas cleanup technology for coal derived gas. Dust elimination and desulfurization.** Akiyoshi, Hisashi; Makino, Hisao; Tanaka, Takashi. Central Research Inst. of Electric Power Industry, Tokyo (Japan). Jul 1988. 33p. (In Japanese). Order Number DE90753076. Available from NTIS (US Sales Only), PC A03/MF A01.

On the hot gas cleanup technology for coal gasification combined power generation, a simultaneous dust elimination and desulfurization system, which is compacted in the structure and is reduced in the power generation cost, has been comparatively studied. Then selection of the optimum system and investigation of the system were carried out, and future subjects to be developed were determined. Five types simultaneous dust elimination and desulfurization systems were investigated, from among those systems, the system combined electrostatic filtration dust collection with moving bed type desulfurization method was selected. It uses same filler in the dust elimination and desulfurization, and high performances can be expected in both of dust collection rate and desulfurization rate. In this system, the pollution velocity by the char particulate adhesion is same as the moving velocity of the reaction zone by desulfurization, therefore, it can be used both as desulfurization section and dust collection section. This system is economical one. For the utilization of this process, the subjects to be solved are to control the reduction of desulfurization performance at the adhesion of char and to prevent the powdering and sintering of desulfurization absorbent at the regeneration. 6 refs., 10 figs., 4 tabs.

19170 (CRIE-W–88008) **Analysis of coal gaseous fuel combustion reaction. Thermal NOx emission characteristics.** Nakata, Toshihiko; Sato, Mikio; Yamauchi, Koji. Central Research Inst. of Electric Power Industry, Tokyo (Japan). Sep 1988. 28p. (In Japanese). Order Number DE90753077. Available from NTIS (US Sales Only), PC A03/MF A01.

On the emission characteristics of CO and thermal NOx in a gas turbine combustor using coal gaseous fuel, the analysis of the combustion reaction using an elementary process model was conducted. It was revealed that the analyzing results agreed well with the experimental data. In the analyzing method, chemical species of fourteen kinds and elementary process equations of twenty-eight types are used for the chemical kinetics in the combustor. An assumption is made that the fuel and air are mixed instantaneously in each section of the combustor axial direction and a combustion gas temperature is stood for by an adiabatic flame temperature. Decomposition behaviors of the main combustible components (CO, H_2) in the combustor and the reactio of thermal NOx formation are revealed through the analyzing method as the following. The thermal NOx formation proceeds rapidly within 0.1 ms reaction time, it is formed in large quantities in near 1.0 excess air ratio at which the combustion gas temperature is especially high. The NOx emission concentrations of the gas turbine combustor calculated by the analyzing method agreed well with the experimental data. 7 refs., 15 figs., 1 tab.

19171 (CRIE-W–88013) **Study on removal of ammonia in coal derived gaseous fuel. Part 2 Effect of nitrogen oxide for ammonia removal.** Yamauchi, Koji; Sato, Mikio; Nakada, Toshihiko. Central Research Inst. of Electric Power Industry, Tokyo (Japan). Oct 1988. 27p. (In Japanese). Order Number

DE90753079. Available from NTIS (US Sales Only), PC A03/MF A01.

In this report, on ammonia removal method from coal derived gaseous fuel, the effect of NOx injection on the ammonia removal by injection of small amount of O_2 was studied through a numerical analysis using an elementary process model. In the reaction kinetics calculation of the model, chemical species of twenty-two kinds and elementary process equations of sixty-three types are used. An assumption is made that all chemical species are mixed homogeneously in the reaction process, no diffusion and mixing are considered. It is revealed that under the conditions of O_2 injection over 1000 ppm in the fuel and over 700°C reaction temperature, the ammonia concentration after the reaction is further reduced by adding NO about 500 ppm in the fuel compared with the case of without adding NO. 8 refs., 12 figs., 2 tabs.

19172 (CRIE-W–88016) **Computer analysis on two stage entrained flow gasifier. Characteristics of the char feed system with the raw syngas.** Mimaki, Toshio; Hara, Saburo; Inumaru, Jun; Moritsuka, Hideto; Hamamatsu, Teruhide. Central Research Inst. of Electric Power Industry, Tokyo (Japan). Dec 1988. 75p. (In Japanese). Order Number DE90753081. Available from NTIS (US Sales Only), PC A04/MF A01.

Various coal gasification experiments have been being conducted using a 2 ton/day two stage entrained flow gasifier in Central Research Inst. of Electric Power Industry. In this report, the knowledge on the gasification characteristics obtained through the experiments so far, were tried to be accumulated taking the form of simulation software. On the other hand, a prediction of the gasification characteristics of the char feed system with the raw syngas, was performed using the 2 ton/day gasifier. As the result, it was shown that the characteristics obtained from the simulation software were qualitatively agreed with those of the 2 ton/day gasifier. As the result of the prediction of the characteristics of the char feed system using the simulation software, it is suggested that the secondary air flow rate in the combustor is needed to increases by a little less than 10% for keeping the combustor gas temperature, for that reason the calorific value of syngas is lowered by several %. 13 refs., 32 figs., 8 tabs.

19173 (DOE/FE–0163) **Comprehensive Report to Congress: Proposals received in response to the Clean Coal Technology III Program opportunity notice.** USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Feb 1990. 144p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90006448. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

This report is a comprehensive overview of the projects selected and all proposals received in response to the Program Opportunity Notice (PON) for Clean Coal Technology III (CCT-III) Demonstration Projects (solicitation number DE-PSO1-89FE61825). The Department of Energy (DOE) issued the solicitation on May 1, 1989. Through this PON, DOE solicited proposals to conduct cost shared clean coal technology projects to demonstrate innovative, energy efficient technologies that are capable of being commercialized in the 1990s. These technologies must be capable of (1) achieving significant reductions in the emissions of sulfur dioxide (SO_2) and/or the oxides of nitrogen (NO_x) from existing facilities to minimize environmental impacts such as transboundary and interstate pollution and/or (2) providing for future energy needs in an environmentally acceptable manner. The CCT-III PON is the third of a series of five solicitations being conducted by DOE as part of the Clean Coal Technology Demonstration Program. This is a technology development program jointly funded by government and industry.

19174 (DOE/MC/22062–2791-Vol.2) **Modeling hydrodynamic mixing in process design and development of fluidized bed gasifiers: Volume 2, Final report.** Blake, T.R.; Richner, D.W. Massachusetts Univ., Amherst, MA (USA). Dept. of Mechanical Engineering. Dec 1989. 157p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-85MC22062. Order Number DE90000445. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

The computer codes CHEMFLUB used for the modeling of hydrodynamic mixing of fluidized bed gasifiers, is described. Included in the report is an example, data files or input, and the following algorithms: plotting of positions, linear regression analysis and graphical display of jet penetration data, entrainment of particles in jets, bubble velocity, and elutriation rate constant and entrainment flux above the TDH. (CBS)

19175 (DOE/MC/22064–2796) **A review of models for the analysis of the injection of densely loaded flows into entrained flow gasifiers: Final report.** Edelman, R.; Rizk, M.A. Science Applications International Corp., Torrance, CA (USA). Nov 1989. 47p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-85MC22064. Order Number DE90000453. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

An analysis of turbulent gas-particle flow has been conducted for which dilute and dense flows were considered. This study showed that, although, there are a variety of models postulated for the analysis of dilute-phase particulate transport, there exists limited information on dense-phase flow. Several derivations of multi-phase flow equations have appeared in the literature. The differences between these equations are in the momentum source terms, the pressure gradient terms and in the convection terms of the dispersed phase momentum equation. In most of the studies on dilute two-phase flow, the effects of the dispersed phase on fluid turbulence have not been considered at all or considered only in an ad hoc fashion. In the few studies where such effects have been incorporated properly, many simplifying assumptions and various empirical constants were introduced. Evaluation of the constants was made via a comparison between model predictions and experimental data. Among these studies the work of Elghobashi and his co-workers, in general, and of Rizk (1985), in particular, provides a foundation for the extension to densely loaded gas/solid flows. Based on this approach, a new mathematical model has been formulated to analyze densely loaded gas/solid flows taking into account particle-particle interactions and gas-particle interactions. 136 refs., 2 figs., 2 tabs.

19176 (DOE/MC/23086–2798) **Investigation of processes to treat zinc-ferrite regeneration offgases in high temperature desulfurization of coal gases: Final report.** Woodland, L.R. Little (Arthur D.), Inc., Cambridge, MA (USA). Aug 1988. 76p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-86MC23086. Order Number DE90000460. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

A bench-scale test program has been performed to evaluate the effect of critical operating variables on sulfur dioxide removal efficiency for two candidate "throwaway" desulfurization processes for treating zinc-ferrite reactor regeneration offgas. These two "throwaway" processes, dual-alkali wet scrubbing and spray dryer desulfurization, generate a gypsum waste sludge environmentally acceptable for disposal. They have seen extensive commercial application in flue gas desulfurization, but have not been evaluated for such high levels of removal efficiency and such high inlet sulfur dioxide concentrations as would be required for this application. 13 figs., 15 tabs.

19177 (DOE/PC/80908–13) **Low severity coal conversion by ionic hydrogenation: Progress report July–September 1989.** Maioriello, J.; Larsen, J.W. Lehigh Univ., Bethlehem, PA (USA). Dept. of Chemistry. 16 Nov 1989. 13p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-85PC80908. Order Number DE90006942. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Objectives of this project were to: explore the ionic hydrogenation of low rank coals using H_2O:BF_3 as the acid and hydrogen gas as the hydride donor in the presence of catalytic quantities of transition metal complexes to activate hydrogen; develop the optimum reaction conditions; and develop other ionic hydrogenation reactions using catalytically activated hydrogen. The following ionic hydrogenation systems were screened using two test compounds in the search for effective acid/H_2/catalyst combinations: H_2O:BF_3/H_2/$(CH_3CN)_2PtCl_2$; BF_3:H_2O/$PtCl_2(CH_3CN)_2$/H_2; H_2O:BF_3/H_2/MoS_2 applied to Beulah Zap lignite; BF_3:H_2O along with Et_3SiH applied either Wyodak subbituminous coal or the THF soluble portion of two select coals, Wyodak and Bruceton; and $NaBH(OAc)_3$ and CH_3SO_3H. Results are discussed.

19178 (DOE/PC/80908–14) **Low severity coal conversion by ionic hydrogenation: Progress report, October–December**

1989. Maiorello, J.; Larsen, J.W. Lehigh Univ., Bethlehem, PA (USA). Dept. of Chemistry. 12 Jan 1990. 10p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-85PC80908. Order Number DE90006878. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The objectives of this project are as follows: (1) to explore the ionic hydrogenation of low rank coals using BF_3:H_2O as the acid and hydrogen gas as the hydride donor in the presence of catalytic quantities of transition metal complexes to activate hydrogen, and (2) develop ionic hydrogenation systems using catalytically activated hydrogen under mild conditions. This quarter's progress included: (1) a variety of ionic hydrogenation systems were screened using two test compounds in the search for effective acid/H_2/catalyst conditions; (2) a new ionic hydrogenation system using H_2O:BF_3/H_2/$(CH_3CN)_2PtCl_2$ was found to hydrogenate aromatics/polynuclear aromatics (PNAs) and to cleave C–O bonds. This system was applied to several coals including Wyodak subbituminous coal, its pyridine extract obtained after ion-exchange, or $K_2S_2O_8$ oxidized Texas Rawhide; (3) an ionic hydrogenation system consisting of BF_3:H_2O/H_2MoS_2 was applied to Beulah Zap lignite to determine the effectiveness of the ionic hydrogenation reaction using heterogeneous transition metal sulfides as catalysts; (4) a series of organic acids and BF_3:H_2O with Et_3SiH as hydride donor were used to hydrogenate Wyodak subbituminous coal and the THF soluble portion of two select coals, Wyodak and Bruceton; (5) a potentially new ionic hydrogenation system CH_3SO_3H/$NaBH(OAc)_3$ as acid/hydride pair was screened using model compounds; and (6) homogeneous transition metal complexes with new phosphine and nitrile ligands were screened in a search for systems having different reactivity and/or selectivity. 12 refs., 3 figs.

19179 (DOE/PC/88891–T3) **Molecular biological enhancement of coal biodesulfurization: Fifth quarter report, November 1989–January 1990.** Bielaga, B.; Kilbane, J.J. Institute of Gas Technology, Chicago, IL (USA). Jan 1990. 17p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-88PC88891. (IGT–61095). Order Number DE90006786. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Research during this quarter was focused on two topics: the development of techniques for the genetic analysis of Rhodococcus rhodochrous IGTS8, and biochemical investigations of the desulfurization trait of IGTS8. Neither transformants nor transconjugants of IGTS8 have been obtained thus far. Biochemical investigations have identified conditions that allow for optimum expression of the desulfurization trait of IGTS8, and have tentatively identified metabolites of trithiane. Research performed during this quarter has shown that the desulfurization trait of IGTS8 is induced in cells grown with trithiane as the sole source of sulfur, and these induced cells can be used in biochemical studies. GC/MS studies have tentatively identified trithiane sulfoxide as a metabolite of trithiane produced by IGTS8. 4 figs.

19180 (DOE/PC/88935–T4) **Inhibition of retrogressive reactions in coal/petroleum co-processing: Quarterly technical progress report, September 1, 1989–November 30, 1989.** Schobert, H.H.; Tomic, J. Pennsylvania State Univ., University Park, PA (USA). Coll. of Earth and Mineral Sciences. Dec 1989. 12p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-88PC88935. Order Number DE90008457. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The overall objective of this project is to develop a fundamental understanding of the reactions occurring at the onset of coke formation during the co-processing of coals with petroleum residua. The specific objectives include examination of chemical components, or groups of components, in coals and petroleum feedstocks to quantify and rank the effects of these components on retardation or enhancement of coke formation. The work involves bench scale reactions in microautoclaves, supplemented by optical microscopy of carbonaceous residues and such instrumental analyses as ^{13}C NMR and GC/MS. During this reporting period the work focused on Task 2, the identification of solvation and dispersion effects. Microautoclave testing of mixtures of model compounds and coals was continued in order to identify those features of model compound structures which are important in solvating the coals. This work is based on the hypothesis that extensive coking can be eliminated or suppressed by having as much as possible of the reacting coal-petroleum mixture in a single liquid phase. 3 refs., 6 figs., 3 tabs.

19181 (EGG-M–89110) **Microbial modification of alkali-solubilized Illinois No. 6 coal.** Wey, J.E.; Jolley, J.G.; Wright, R.B.; Dugan, P.R.; Stoner, D.L. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 10p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC07-76ID01570. (CONF-891130–4: 3. international conference on processing and utilization of high-sulphur coals, Ames, IA (USA), 14-18 Nov 1989). Order Number DE90007011. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Bacterial cultures capable of dibenzothiophene (DBT) degradation were tested for their ability to modify the organosulfur constituents in an alkali-solubilized Illinois No. 6 coal product. Buffered solutions of solubilized coal were incubated one week with bacterial cultures designated A4, C18, E1, UPL–CPS2 and DK10 and then analyzed by Fourier transform infrared spectroscopy (FTIR), X-ray photoelectron spectroscopy (XPS) and elemental analysis. With one week of incubation at 25–27°C, slight modification of coal structure by microorganisms was observed. Elemental analysis indicated that isolates C18 and UPL-CPS2 decreased the amount of sulfur relative to the carbon in the coal product, and all bacterial treatments resulted in slight increases in oxygen content, slight decreases in carbon to oxygen ratios, and significant decreases in ash content. FTIR analysis showed a slight increase in carbonyl and aliphatic functionalities relative to other organic groups. Absorption bands corresponding to organosulfur groups could not be accurately determined because of weak absorption signals due to low organic sulfur concentration (<2%) and interferences from other organic groups present in the solubilized coal. No changes in the ratio of oxidized sulfur to reduced sulfur were observed with XPS. 16 refs., 6 figs., 2 tabs.

19182 (ORNL/Sub–85-55904/02) **Development of a design methodology for high temperature cyclic applications of materials which experience cyclic softening: Final technical report, May 1, 1985–September 30, 1988.** Marriott, D.L. (Illinois Univ., Urbana, IL (USA). Dept. of Mechanical and Industrial Engineering); Stubbins, J.F. Oak Ridge National Lab., TN (USA); Illinois Univ., Urbana, IL (USA). Dept. of Mechanical and Industrial Engineering. Dec 1988. 144p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC05-84OR21400. Contract 19X-559904C. (UILU-ENG–88-4020). Order Number DE90006722. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

The project has as its original focus the high temperature behavior of 2.25 Cr-1 Mo steel, heat treated to produce a predominantly bainitic microstructure and the load carrying response of components made of this material. Experiments were carried out on uniform and notched specimens under both steady and cyclic loading using specially acquired electromechanical test machines. It emerged that a very important feature of mechanical behavior under the conditions of interest was the strong tendency of this material to cyclically soften, particularly at high temperature in the creep range, giving the illusion of a severe creep-fatigue interaction under certain conditions. This finding led to a significant component of the project being devoted to investigation of the effects of local, as opposed to generalized, cyclic softening, and the implications this phenomenon might have on the setting of allowable design stress limits. The format of this report is as follows: The second chapter is a review of the work carried out in approximately chronological order under the headings of work was carried out under the following: (1) 2.25 Cr 1 Mo Steel – Elevated Temperature Fatigue and Environmental Effects; (2) Preliminary Studies of Advanced Austenitics; (3) A Uniaxial Constitutive Model for Cyclic Softening; (4) The Iso-Cyclic Stress-Strain Approach to Evaluation of Components in Cyclic Softening Materials; (5) Testing of High Temperature Austenitic Alloys; and (6) Design Methodology for Aging Materials – Application to Cyclic Softening. 65 refs., 39 figs., 7 tabs.

19183 (SAND–89-2023C) **Trickle-bed reactor for investigating upgrading reactions.** Kottenstette, R.J.; Stephens, H.P. Sandia National Labs., Albuquerque, NM (USA). [1990]. 13p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900391–1: 1990 American Institute of Chemical Engineers (AIChE) spring meeting, Orlando, FL (USA),

18-22 Mar 1990). Order Number DE90006045. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The catalytic processing of heavy petroleum feeds and many of the heavier synthetic fuels is performed in the liquid phase and quite often in trickle-bed reactors. In this paper we present the basis for the design of a microscale trickle-bed reactor for studying the kinetics of reactions related to coal liquefaction processes. This small (10 cm-long) catalyst bed was used to study the hydrogenation of naphthalene to tetralin at 373 K and the hydrogenation of pyrene to dihydropyrene at 573 K. The hydrogenation of naphthalene to tetralin using a palladium (Pd) catalyst has been shown to be a pseudo-first-order irreversible reaction at 373 K, while the hydrogenation of pyrene to dihydropyrene using a nickel molybdenum on alumina catalyst (NiMo/alumina) has been shown to be a pseudo-first-order reversible reaction at 573 K. First-order kinetic plots for the flow reactor experiments show that plug-flow behavior was achieved for both the hydrogenation of naphthalene and pyrene. In addition, plug flow was not perturbed by increasing the hydrogen gas flow by a factor of four. A reactor of such small scale with achievable plug flow behavior is an important tool for catalyst activity testing since it provides the ability to adjust reaction conditions easily and allows catalyst deactivation to be studied more effectively. In addition, a wide variety of hydrotreating reactions including hydrodesulfurization (HDS), hydrodeoxygenation (HDO), and hydrodenitrogenation (HDN), can be studied using this simple reactor design. 10 refs., 6 figs., 1 tab.

19184 (SAND–89-2400) **Hydrous metal oxide-supported catalysts: Part 2, Catalytic properties and applications.** Dosch, R.G.; Stephens, H.P.; Stohl, F.V. Sandia National Labs., Albuquerque, NM (USA). Feb 1990. 149p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC04-76DP00789. Order Number DE90008098. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

This report describes research leading to the development of new catalytic materials based on hydrous metal oxide (HMO) ion exchangers. Present in this part, the second of two parts, are results of catalyst-related research and application of the materials to catalytic reactions for direct coal liquefaction processes. HMO materials are inorganic ion exchangers, derived from the alkoxides of Ti, Zr, Nb, or Ta, that exhibit a number of properties applicable to the preparation of catalysts. Research on the catalytic properties of HMO's has focused on the hydrous titanium oxide (HTO) system. However, exploratory coal liquefaction experiments with hydrous niobium oxides (HNO's) and hydrous zirconium oxides (HZO's) have demonstrated that these HMO's also exhibit potential as coal liquefaction catalysts. Studies performed during the course of this research include (1) preliminary coal liquefaction and hydrotreating tests, (2) tests of hydrogenation, hydrodesulfurization, hydrodeoxygenation and hydrodenitrogenation activity using model compounds, (3) development of catalyst pretreatment and activation procedures, (4) modification of HTO supports with silicon, (5) preparation and testing of thin film HTO catalysts, (6) synthesis, characterization and evaluation of base and noble metal catalyst deactivation tests, and (9) exploratory tests of applications other than direct liquefaction. The versatility of the HTO system for synthesis of catalysts allows great potential for further improvements in activity and selectivity as well as tailoring of catalysts for specific processes. Research is continuing in these areas. 54 refs., 63 figs., 25 tabs.

19185 (SAND–90-7028C) **Assessing the economics of advanced indirect liquefaction process concepts.** Gray, D. (Mitre Corp., McLean, VA (USA)); Tomlinson, G. Sandia National Labs., Albuquerque, NM (USA). c Jan 1990. 31p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC04-76DP00789. (CONF-900391–3: 1990 American Institute of Chemical Engineers (AIChE) spring meeting, Orlando, FL (USA), 18-22 Mar 1990). Available from Sandia National Laboratories, Technical Library-3140, Albuquerque, NM 87185.

The objectives of this study are to estimate the cost of production of high quality transportation fuels from advanced coal-based indirect liquefaction processes and to determine the economic impact on the cost of these fuels that results from coproducing electric power using the once-through Fischer-Tropsch (OTFT) concept. Integrated computerized simulation models of commercial-scale indirect liquefaction facilities have been developed to accomplish these objectives. The baseline plant consists of Shell entrained coal gasification, slurry phase Fischer-Tropsch (FT) synthesis, and product upgrading, including wax hydrocracking, to produce gasoline, diesel and LPG. In addition the OTFT plant model includes gas turbines, heat recovery steam generators, and steam turbines that make up the combined-cycle section of the plant. 12 refs., 11 figs., 5 tabs.

19186 Pumping carbon and hydrogen out of the ground using the HYDROCARB process. Steinberg, M. (Brookhaven National Laboratory, New York (USA). Dept. of Applied Science); Grohse, E.W. pp. 542 of Proceedings, international underground coal gasification symposium 1989. Delft University of Technology, Congress Office, Delft (Netherlands) (1989). (CONF-891058–: International underground coal gasification symposium, Delft (Netherlands), 9-11 Oct 1989).

A new concept for UCG is proposed in which underground coal seams are hydrogenated with a hydrogen-rich gas in an injection-well to form a methane-rich production-well gas stream. The exit methane-rich gas stream, is decomposed to carbon black and a hydrogen-rich gas stream above ground. Part of the hydrogen-rich gas stream is withdrawn as a clean product gas and the remainder is recycled underground to, once again, hydrogenate the coal underground. Unlike conventional steam gasification of coal, which is an endothermic process requiring either oxygen or air to combust with coal underground to provide the endothermic heat of reaction, the hydrogenation of coal underground is exothermic which maintains the temperature of the bed in the reaction between the coal and hydrogen to methane. This process thus, in effect, pumps carbon fuel out of the ground with the use of hydrogen. Furthermore, it is a much safer system to operate than the steam-oxygen gasification of underground coal. 2 refs., 2 figs.

19187 Mineral transformations in selected coals - Size and composition of the ash. Helble, J.J. (PSI Technology Co., Andover, MA (USA)); Srinivasachar, S.; Katz, C.B.; Boni, A.A. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 34(2): 383-390 (1989). (CONF-8904164–: Symposium on ash deposition: mineral matter transformations during combustion, Dallas, TX (USA), 9-14 Apr 1989).

The transformation of minerals during pulverized coal combustion has been examined by burning utility sized coals (70% < 200 mesh) in a laboratory-scale combustor. Experiments were conducted with several coals possessing different mineralogies, with particular attention paid to Kentucky # 11 bituminous. Size and composition of the initial minerals and the resulting ash were measured by a variety of techniques, including computer controlled SEM, low temperature ashing, deposition on a cascade impactor, and optical (Malvern) particle size analysis. Results for the Kentucky # 11 coal suggest a large degree of coalescence is occurring between illite, kaolinite, and quartz minerals, with occasional iron incorporation into the resulting glass. Partitioning of the acid-leachable potassium was found to split between incorporation into the glass and vaporization. For other coals, such as Buelah lignite, mineral fragmentation was inferred from the data, presumably due to large quantities of large (> 40 microns) pyrite present.

0106 Properties and Composition

Refer also to citation(s) 19187, 19218, 19225, 19229, 19237

19188 (CONF-900402–3) **Pyrolysis of surface-immobilized model compounds: Mechanistic implications for the thermal chemistry of coal.** Buchanan, A.C. III; Britt, P.F.; Poutsma, M.L. Oak Ridge National Lab., TN (USA). [1990]. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 199. national meeting of the American Chemical Society; Boston, MA (USA); 22-27 Apr 1990. Order Number DE90005278. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Our research has been investigating the potential role that the cross-linked network structure of coal may play in perturbing free-radical reactions associated with coal thermolysis. This may be

particularly important in the thermal conversion of coal at low temperatures, e.g., 350–400°C, where bonds begin to break but most of the residual framework is retained. In order to assess the potential impact of restricted transport on thermal reaction pathways, we have modeled the phenomenon experimentally by studying organic model compounds that are covalently linked to an inert silica surface. The experimental methodology and significant results from studies of the thermolysis of surface-attached $Ph(CH_2)_nPh$ [n = 0–4] at 345–400°C will be briefly surveyed. Initial results from studies of two-component surfaces will also be presented that reveal the role of radical migration, via facile hydrogen shuttling, in modifying the effects of diffusional constraints. 13 refs., 5 figs.

19189 (DOE/METC–89/4090) **An overview of literature data on sulfur evolution during coal devolatilization.** Khan, M.R.; Phillips, G.R. USDOE Morgantown Energy Technology Center, WV (USA). Apr 1989. 91p. Sponsored by U.S. DOE Fossil Energy. Order Number DE89011697. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This paper represents an overview of the chemistry of sulfur found in coal, and the important results derived from previous studies that investigated how these species evolve during coal conversion processes. Over 50 papers were reviewed, computer searches of various data bases were performed, and the abstracts of an additional 8 papers were examined. This review of the literature data covers the majority of the available data in this area. This report briefly discusses the influences of temperature, heating rate, atmosphere, additives and coal properties on coal conversion, and the fate of coal sulfur during heat treatment and combustion. Several important conclusions and recommendations are discussed. 49 refs., 49 figs., 36 tabs.

19190 (DOE/PC/79914–T10) **Macromolecular coal structure as revealed by novel diffusion tests: Quarterly technical progress report, September 15, 1989–January 15, 1990.** Peppas, N.A.; Olivares, J. Purdue Univ., Lafayette, IN (USA). School of Chemical Engineering. [1990]. 52p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-87PC79914. Order Number DE90006790. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Analysis of dynamic swelling results from macromolecular networks swollen by thermodynamically good solvents yields information about the structure of the network and its solvent-network interactions. Diffusion studies can be used to identify the thermodynamic state of the network, i.e., whether the network exists in the glassy or rubbery state. For a macromolecular network, it is possible to determine whether sorption is due to Fickian diffusion, macromolecular chain relaxations, or due to a coupling of the two phenomena. In order to understand the mechanisms that govern the sorption of penetrants into the coal network, it is necessary to study and understand the concentration, temperature, and penetrant activity effects on diffusion, as well as particle geometry, network crosslinking density, network, and penetrant-network compatibility. 27 refs., 23 figs., 3 tabs.

19191 (EGG-M–88493) **The influence of microbial metabolites on low-rank coals solubility in alkaline solutions.** Quigley, D.R.; Dugan, P.R. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 13p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC07-76ID01570. (CONF-890562–1: 14. annual fuel science conference, Palo Alto, CA (USA), 18-19 May 1989). Order Number DE90006968. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Acid extraction of coal at ambient temperatures and pressures under nonoxidizing conditions can remove small amounts of mineral matter. Acid extracts contained primarily iron and calcium. The removal of this mineral matter enhances the solubilities of low rank coals tested from 145 to 675% in dilute alkaline solutions. This treatment also enhances the abilities of microorganisms to solubilize coals. These data suggest that multivalent cations bind with coals in such a way as to render them more insoluble in alkaline solutions and more resistant to microbial solubilization. Preliminary work indicates that those microorganisms which are more efficient coal solubilizers use extracellular substances that are active on the metal components of coal to enhance solubilities. 15 refs., 4 figs., 2 tabs.

19192 **Applications of supercritical fluid chromatography-mass spectrometry in the analysis of fossil fuels.** Chess, E.K. (Pacific Northwest Lab., Richland, WA (USA)); Kalinoski, H.T.; Wright, B.W.; Udseth, H.R.; Smith, R.D. pp. 200 of Novel techniques in fossil fuel mass spectrometry. Ashe, T.R.; Wood, K.V ASTM, Philadelphia, PA (1989). DOE Contract AC06-76RL01830. (CONF-8705379–: Novel techniques in fossil fuel mass spectrometry, Denver, CO (USA), 24-29 May 1987).

The authors describe the application of supercritical fluid chromatography-mass spectrometry (SFC-MS) and related techniques to the chemical characterization of a variety of fossil fuels, including diesel fuels, diesel fuel sediments, and petroleum- and coal-derived liquids and solids. Supercritical fluid chromatography can provide either high resolution or extremely rapid separation of complex fuel-derived mixtures. Insoluble sediments from marine diesel fuels can be extracted with polar supercritical fluids and the extracts directly introduced to a mass spectrometer for on-line characterization. Chemical class separations and mass spectrometric analysis of coal-derived liquids can be accomplished by utilizing high-performance liquid chromatography columns and a specially designed interface to the mass spectrometer.

19193 **Surface characterization of alkali-treated coals.** Baltrus, J.P. (USDOE Pittsburgh Energy Technology Center, PA (USA)); Diehl, J.R.; D'Este, J.R.; Ladner, E.P. *Fuel (UK)*, 69(1): 117-121 (Jan 1990).

The surface interactions of alkali with coal and mineral matter have been studied by electron spectroscopy for chemical analaysis (ESCA) to establish a basis for predicting the relative reactivity of alkali with sulphur during coal beneficiation processes. The speciation of sulphur in coals doped with various alkali salts was determined and quantified after heating the mixtures to 648 K in air or N_2, then washing with water. Organic and pyritic sulphur on the surface react with alkali when heated, and the sulphide or oxidized sulphur product can then be washed from the coal. The extent of reaction between the alkali salt and surface sulphur is governed by the size of the cation and the electronic properties of the anion; larger alkali cations are more effective in promoting the reactivity of surface sulphur, as are anions with stronger nucleophilic properties. 14 refs., 2 figs., 5 tabs.

0108 Waste Management

Refer also to citation(s) 19169, 19173, 19176, 19229, 19234, 19242, 19541, 19543, 19735, 19825, 20278

19194 (CONF-890526–3) **Bioremediation of former manufactured gas plant sites.** Srivastava, V.J.; Kilbane, J.J.; Kelley, R.L.; Gauger, W.K.; Akin, C. Institute of Gas Technology, Chicago, IL (USA). [1989]. 28p. Sponsored by Institute of Gas Technology. From 44. annual Purdue industrial waste conference; West Lafayette, IN (USA); 9-11 May 1989. Available from OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616.

Gasification of coal and crude oil was extensively used in the United States to produce medium to high heating value gas during the nineteenth and twentieth centuries. Consequently, many of these plants disposed of process wastes and less valuable byproducts onsite, contaminating the soils with coal tar wastes, light oils, naphthalene, etc. Polynuclear aromatic hydrocarbons (PAH's) are components of coal tar wastes and other wastes that remain at many of these town gas sites. The Institute of Gas Technology (IGT) has been developing several techniques to improve biodegradation of town gas plant wastes such as multi-ring PAH's. These techniques include the use of bioemulsifiers, chemical oxidants or biologically produced chemicals, PAH-degrading IGT aerobic and anaerobic bacterial cultures developed through enrichment techniques, methane utilizing organisms (methanotrophs), fungi, and appropriate co-metabolic and/or enzyme-inducing substrates. Depending upon the waste type and concentration, and hydrogeochemical characteristics of the site, a logical combination of some of these techniques can be used to remediate the site. 9 refs., 15 figs., 3 tabs.

19195 (CONF-891111–4) **Accelerated biodegradation of coal-tar wastes in soil.** Srivastava, V.J. (Institute of Gas Technology, Chicago, IL (USA)); Kilbane, J.J.; Kelley, R.L.; Akin, C.; Hayes, T.D.; Linz, D.G. Institute of Gas Technology, Chicago, IL (USA). [1989]. 14p. Sponsored by Institute of Gas Technology. From International gas research conference; Tokyo (Japan); 6-9 Nov 1989. Available from OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616.

The Institute of Gas Technology (IGT) has been developing several techniques to improve biodegradation of town gas plant wastes such as multi-ring polynuclear aromatic hydrocarbons (PAH's). These techniques include the use of bioemulsifiers, chemical oxidants or biologically produced chemicals, PAH-degrading cultures developed by IGT through enrichment techniques, and appropriate co-metabolic and/or enzyme-inducing substrates. Depending upon the waste type and concentration, and geological characteristics of the site, a logical combination of any number of these techniques can be used to remediate the site. This paper discusses several liquid culture and soil treatment experiments conducted at IGT. Results show that PAH's in soils and in waters can be efficiently biodegraded by aerobic and possibly by anaerobic cultures and that chemical treatment and bioemulsifier applications enhance PAH biodegradation. This paper also mentions possible treatment scenarios consisting of various unit operations or remediation techniques. 9 refs., 11 figs., 2 tabs.

19196 (DOE/MC/23259–2781) **High temperature interaction of SO_2 with oxide sorbents: Final report.** Seehra, M.S.; Thevar, G.R. West Virginia Univ., Morgantown, WV (USA). Dept. of Physics. Jun 1989. 53p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-86MC23259. Order Number DE90000435. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The primary objective of this project was to carry out a thorough investigation of the kinetics of the interaction of SO_2 gas with CaO particles at temperatures between 25°C and 1000°C. Our goal was to develop the new technique of FTIR (Fourier Transform Infra Red) spectroscopy for studies of the SO_2–CaO interaction so as to determine not only the kinetics but also the nature of the chemical products of the reaction for temperatures to 1000°C. Further, our goal was to determine the effect of oxygen on the kinetics and products of the reaction. In addition, techniques of ESR (Electron Spin Resonance) spectroscopy and TGA (Thermogravimetric Analysis) were to be employed to support these studies. It was hoped that results of these studies would clear many of the inconsistencies reported in literature on the sulfation of CaO. Results of these studies as well as results on the interaction of SO_2 with calcined $CaCO_3$ and $MgCO_3$ (calcined at 700°C), for temperatures up to 700°C, are given in this report. 44 refs., 23 figs., 9 tabs.

19197 (ECN–89-184) **Modelling chemical interactions at a waste/waste interface.** Van der Sloot, H.; Cote, P. Netherlands Energy Research Foundation, Petten (Netherlands). Dec 1989. 8p. Available from Netherlands Energy Research Foundation ECN, P.O. Box 1, 1755 ZG Petten, Netherlands.

The interfacial phenomena between an acidic and an alkaline fly ash were observed in small diffusion tubes using a slicing technique. pH profiles were determined by extracting each slice with water while a zinc profile was measured using a radioactive tracer. The alkaline fly ash slowly neutralized the acidic ash, resulting in precipitation of the zinc within the acidic ash, near the interface. A numerical model based on transport by diffusion in the pore water and on instantaneous chemical reactions of neutralization and precipitation was used to describe the observed phenomena. 4 figs., 5 refs.

19198 (EUR–12316-DE) **Investigation of the crushing behaviour of colliery and washery discard with a view to further utilization.** Leonhard, J.; Schieder, T. Bergbau-Forschung GmbH, Essen (Germany, F.R.). 1989. 75p. (In German). Available from Commission of the European Communities, Luxembourg.

The aim of the research was to produce size fractions of the dirt content of run-of-mine coal, by suitable crushing and classifying methods, which can be used in the building industry as aggregates for construction and paving blocks as well as for concrete making. Basic investigations into the possible exposure and separation of coal and clay fractions and the preparation of favourably-sized aggregate material by means of dirt crushing saw the introduction of a number of different crushing machines which were supplied with regionally-selected discard from various collieries. The results of these trials led to a concept for two-stage crushing using impact mills. In the first stage (preliminary crushing) it was intended to eliminate as high as possible a proportion of organic and soft clay material by selective crushing, this to be discarded by a process of subsequent classification. In the second stage (secondary crushing) superior material can also be obtained from the coarse sizes. By adopting this system, it is possible to produce materials which, when employed as aggregate for sand-lime bricks or concrete building blocks, result in products of marketable quality and strength. The investment costs for a two-stage crushing installation with a throughput of 100,000 t/a and producing sand and chippings are around DM 1.8 million. Initial estimates give an operating cost of about 6.00 DM/t.

19199 (SVF–345) **Coal combustion residues.** Hartlen, J.; Rogbeck, J.; Lindau, L.; Nilsson, C. Stiftelsen foer Vaermeteknisk Forskning, Stockholm (Sweden). Jul 1989. 127p. (In Swedish). Available from Stiftelsen foer Vaermeteknisk Forskning, Stockholm (Sweden).

This report discusses the properties and utilization options in Sweden for residues from pulverized coal combustion, fluidized bed combustion and coal gasification. Pulverized coal ash may be mixed with cement to produce strong impermeable materials, e.g., Cefill. Desulphurisation products may be used to improve the hardening properties of fly ash cements, or can be used in building materials, e.g., gypsum plasterboard. Lowering the emission of nitrogen oxides will influence residue properties and hence their potential usefulness. Residues from fluidized beds are crystalline and non-pozzolanic and are unsuitable as cement additives. Their greatest use is likely to be as fillers, road construction and erosion protection materials, etc. Pressurized fluidized bed residues are particularly well suited to these applications. Handling of residues is controlled by environmental protection regulations. Urban areas probably present the most suitable environments for residue utilization as in such areas the material will be covered by hard surfaces, minimizing the water infiltration. With the increase in coal combustion capacity which is likely in the future, there will be an international surplus of marketable residues. Actual consumption of gravel in Sweden is compared with the potential use of synthetic gravels, fillings and similar materials.

19200 (VTT-SYMP–103, pp. 51-53) **Non-waste processes in energy production. The Sulfred-process for flue gas desulfurization.** Tinnis, A. (Outokumpu Oy, Espoo (Finland) Engineering Division); Aastroem, L. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). 1989. (CONF-8806445–Vol.2: Seminar on non-waste technology, Espoo (Finland), 20-23 Jun 1988). In *Non-waste technology: Volume 2.* Order Number DE90748455. Available from NTIS (US Sales Only), PC A16/MF A01.

Outokumpu Oy, a major mining and metallurgical company in Finland, has developed a genuine non-waste process for the desulfurization of process gases such as power plant flue gas or metallurgical stack gases. It is a fully generative method, called Sulfred.

19201 (VTT-SYMP–103, pp. 285-293) **Dry flue gas desulfurization by the LIFAC process.** Kenakkale, T. (Tampella Ltd, Tampere (Finland). Boiler Division); Laine, L. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). 1989. (CONF-8806445–Vol.2: Seminar on non-waste technology, Espoo (Finland), 20-23 Jun 1988). In *Non-waste technology: Volume 2.* Order Number DE90748455. Available from NTIS (US Sales Only), PC A16/MF A01.

A desulfurization process, to be fully adopted in the utility industry, should be economically viable, meet emission standards and be fully reliable in continuous operation. The industrial LIFAC process has been developed and designed on the basis of the results of pilot and full-scale tests, which are briefly described in this paper. An economic study clearly indicated that the LIFAC process is feasible when compared with wet or spray processes. According to the cost level of the year 1986 the total costs for desulfurization vary from 4 to 6 FIM/MWh calculated per fuel heat output within

the range of 150 to 1250 MW. The first full-scale LIFAC plant is operating at Imatran Voima Oy's power plant in Inkoo, Finland. After a very intensive test period in the winter 1986-1987, Imatran Voima ordered a new LIFAC reactor for the Inkoo power plant. The new reactor was commenced in the year 1988.

19202 (VTT-SYMP–103, pp. 352) **Coal combustion experiments with the 1 MW atmospheric FBC boiler for improving the combustion efficiency and use of the wet scrubber for dust, SO_2 and NO_x removal.** Malinen, H. (Technical Research Centre of Finland, Jyvaeskylae (Finland). Domestic Fuel Laboratory). Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). 1989. (CONF-8806445–Vol.2: Seminar on non-waste technology, Espoo (Finland), 20-23 Jun 1988). In *Non-waste technology: Volume 2.* Order Number DE90748455. Available from NTIS (US Sales Only), PC A16/MF A01.

A 1 MW atmospheric fluidised bed boiler and a wet scrubber were used as an integrated unit in order to examine the combustion efficiency and dust, SO_2, and NO_x removal. A total of 26 experiments were carried out, each of them lasting about 4 hours. The coals used were from USA and USSR, their most significant differences being in size distribution and ash content. Two different types of limestones were also used for sulphur removal in the boiler furnace. The limestones were both from Lohja Oy Tytyri mine and differed only in size distribution. The sulphur removal was at its maximum about 60%, the Ca/S molar ratio being 3.1. The study indicated that the most efficient variable was the bed temperature, its obtimum being 800-820 deg C. A clear dependence was also detected between the limestone feeding point and the size distribution. The best results were obtained by feeding coarse limestone to bed or fine limestone to freeboard. The fuel itself did not have any clear effect on sulphur capture. The sulphur content of both coal grades was 0.8-1.0%. The measurements in the boiler freeboard area gave the highest values of dust content and unburned carbon with fine coal. The coal quality was the most important factor affecting the combustion efficiency in these experiments. Sulphur removal in the wet scrubber was 90-96%. The best results were obtained simultaneously with the highest sulphur removal efficiencies in the boiler furnace. The total sulphur removal of the integrated unit was 90-98% in all experiments. The wet scrubber could also reduce the amount of NO_x emissions significantly. Dust removal exceeded 95% in all experiments. Most of the dust was separated in a cyclone prior to the wet scrubber and the rest in the scrubber.

19203 **Rocky Mountain 1 groundwater restoration: first treatment.** Speight, J.G. (Western Research Institute, Laramie, WY (USA)); Covell, J.R. pp. 542 of Proceedings, international underground coal gasification symposium 1989. Delft University of Technology, Congress Office, Delft (Netherlands) (1989). (CONF-891058–: International underground coal gasification symposium, Delft (Netherlands), 9-11 Oct 1989).

The Rocky Mountain 1 test was conducted to evaluate two promising UCG technologies and to address environmental issues, particularly with respect to groundwater contamination. Results show that: contaminated water was effectively collected and contained in the gasification cavities, no oil was observed in the oil and water separation system, oxidation using chlorine effectively reduced the ammonia concentration, carbon adsorption effectively removed phenols from the groundwater, the groundwater did not contain measurable concentrations of heavy metals, boron was not significantly reduced in the treatment system, and the addition of chlorine, sulfuric acid and sodium hydroxide increase the TDS concentration of the treated water that is deposited in the soil. 11 refs., 5 figs., 1 tab.

0109 Environmental Aspects

Refer also to citation(s) 19159, 19203, 19247, 19248

19204 (CRIEPI-T–88087) **Field study on the behavior of trace elements in coal-fired power plants.** Yokoyama, T. (and others). Central Research Inst. of Electric Power Industry, Tokyo (Japan). 1989. vp. (In Japanese). Available from Central Research Institute of Electric Power Industry, Tokyo, Japan.

A field study on the behaviour of trace elements (Al, As, B, Be, Ca, Cd, Cl, Co, Cr, Cu, F, Fe, Hg, Mg, Mn, Mo, Ni, Pb, Sb, Se, Si, V, Zn, BaP) has been carried out at three coal-fired power plants (capacities 500, 500 and 350 MW). The emission factors derived from this study were applied to estimate the maximum ground-level concentrations of trace elements from a model of 1,000MW coal-fired power plant. The estimated maximum ground-level concentrations of trace elements from the power plant were 1/100 to 1/10,000 of the mean values of observed concentrations at sixteen sites in Japan.

19205 (PB–90-855339/XAB) **Acid mine drainage. January 1977-January 1989 (Citations from the Selected Water Resources Abstracts data base). Report for January 1977-January 1989.** National Technical Information Service, Springfield, VA (USA). Dec 1989. 217p. Available from NTISPC N01/MF N01.

See also PB–90-855347.

This bibliography contains citations concerning the control and treatment of acid mine drainage. Techniques discussed for treating wastes with heavy metals include precipitation, cementation, ion exchange, charge membrane, ultrafiltration, ozonation, solvent extraction, and electrodialysis. The environmental impacts of acid mine drainage on rivers, streams, and lakes are also discussed. (This updated bibliography contains 344 citations, none of which are new entries to the previous edition.)

19206 (PB–90-855347/XAB) **Acid mine drainage. February 1989-December 1989 (Citations from the Selected Water Resources Abstracts data base). Report for February 1989-December 1989.** National Technical Information Service, Springfield, VA (USA). Dec 1989. 45p. Available from NTISPC N01/MF N01.

Supersedes PB–89-854863. See also PB–90-855339.

This bibliography contains citations concerning the control and treatment of acid mine drainage. Techniques discussed for treating wastes with heavy metals include precipitation, cementation, ion exchange, charge membrane, ultrafiltration, ozonation, solvent extraction, and electrodialysis. The environmental impacts of acid mine drainage on rivers, streams, and lakes are also discussed. (This updated bibliography contains 54 citations, all of which are new entries to the previous edition.)

19207 **Atmospheric behavior of trace elements on particles emitted from a coal-fired power plant.** Ondov, J.M. (Lawrence Livermore National Laboratory, CA (USA)); Choquette, C.E.; Zoller, W.H.; Gordon, G.E.; Biermann, A.H.; Heft, R.E. *Atmospheric Environment (UK),* 23(10): 2193-2204 (1989).

Filter and cascade impactor samples of suspended particles were collected in-stack and at distances up to 64 km downwind in the plume of a large western coal-fired power plant equipped with both electrostatic precipitators (ESP) and venturi wet particulate scrubbers (VWS) to investigate modifications of the particulate signatures of minor and trace elements during transport. Samples were analyzed for 40 elements by instrumental neutron activation analysis. Precipitator malfunctions during the experiment caused greater than normal emission of large particles, and concentrations of As, Zn, Sb, Mo, Ga, W, U, V and Ba in near-plume particles collected on filters were enriched relative to their concentrations in stack particles by factors of 1.4 to 2.5, presumably because of sedimentation of very large particles. Selenium was enriched by up to 6-fold (plume:stack). However, enrichment of elements in the plume relative to more typical in-stack particles was insignificant for all elements except Se, which was enriched 2.3-fold. Concentrations of Se on particles in the stack and plume suggest that most of the Se vapor in stack gases became associated with aerosol particles soon after emission. Thus although significant post-emission modifications of elemental signatures of particles may occur for poorly controlled plants, little change is expected for well-controlled plants equipped with ESPs except for Se. Source signatures measured for Se must account for vapor deposition. Impactor data showed a preferential decrease in the concentrations of the above elements in submicrometer particles; suggesting that either intermodal coagulation or size selective sampling losses were important. The impactor data further suggest that enrichment-particle-size profiles for VWS emissions were not conservative during transport. 26 refs., 6 figs., 9 tabs.

0120 Mining

19208 (EUR-12071-EN) **Data gathering techniques.** British Coal Corp., Stanhope Bretby (UK). Headquarters Technical Dept. 1989. 70p. Available from Commission of the European Communities, Luxembourg.

Recent increased competition in the energy market has accelerated the need for the British Coal Corporation to increase production efficiency by increasing machine utilisation. This aim necessitates a comprehensive knowledge of plant operation and machine performance over the full operating spectrum, and a thorough understanding of strata behaviour during the coal extraction process. In achieving this objective, portable underground instrumentation will have an important part to play. Firstly, it will compliment existing on-board surveillance devices, providing additional on-site or more detailed information, and secondly, it will enable parameters to be recorded in areas where permanent instrumentation is not available. A portable solid-state modular instrumentation package has been developed, specifically for use in operational and investigational applications. The interchangeable modular flexibility of the system permits a variety of configurations to suit specific applications. The system is compatible with existing data transmission systems for on-line monitoring or long-term data gathering. In-situ verification that data have been successfully recorded and the ability to display data underground were essential features. Additionally recorded data can be retrieved underground and manually brought to the surface for computer analysis. Since the commencement of this work, five recording elements, two data retrieval units, and a 4-channel signal conditioning unit have been developed. All the instrumentation developed complies with recognised standards concerning analogue signals in coal mines, and is certified intrinsically safe to BS1259:1958 or are in the process of being certified. 6 refs., 24 figs., 6 tabs.

19209 (EUR-12075-DE) **Development of winning machines to improve the quality of raw coal II.** Plum, H.; Vitek, H.; Wolter, H. Bergbau-Forschung GmbH, Essen (Germany, F.R.). 1989. 104p. (In German). Available from Commission of the European Communities, Luxembourg.

Efficient and safe mining of hard coal is possible by means of using percussion- and vibration-activated hydraulic cutting tools. Their sturdy design largely precludes any externally induced malfunctions. Cutting forces are considerably reduced in comparison with static tools. The extracted material is of lump size and low moisture content and, as such, promises as good sales profits as high-grade coal. Extremely little dust is produced during extraction. It is still premature to finally assess the application potentials of different activated cutting tools either of the hydraulic/translatory or of the mechanical/rotary type. The above fundamental studies have to be followed by other long-term tests also carried out underground. As for activated loading machines, any final assessment cannot be given as yet although the surface and underground trial runs on rotative disk loaders have been encouraging. Remarkable loading efficiencies were attained with at the same time low defect-proneness. It remains to be demonstrated by continued tests however, whether the high technical expenditure for reducing the tensile forces of chains is justifiable.

19210 (EUR-12083-EN) **Electronic time study.** British Coal Corp., Stanhope Bretby (UK). Headquarters Technical Dept. 1989. 21p. Available from Commission of the European Communities, Luxembourg.

British Coal have developed, in conjunction with Anderson Strathclyde plc, a fully comprehensive work measurement system using the Anderson Strathclyde CS21 Data Capture Unit (DCU) for data collection and a personal computer (PC) for analysing the data and producing the final report. There are three complementary parts to the software for this system. The applications software was developed by Anderson Strathclyde plc for use within the DCU while the software for data transmission and analysing the study results was developed by British Coal. This project covered the development and testing of the applications software for two of the study types used in British Coal, i.e., Time Study and Operational Timing, and also the facility to change between study types during a study. Time study is a technique for measuring the times and assessing the rates of working for the elements of a specified task carried out under specified conditions, and for analysing the data to determine the time necessary for carrying out the task at a defined rate of working. Operational timing is a modified form of time study by means of which one engineer can study groups of men working with or without machines in a confined work situation. 6 figs.

19211 (EUR-12085-EN) **Monitoring and prediction of the life of mining chain assemblies.** British Coal Corp., Stanhope Bretby (UK). Headquarters Technical Dept. 1989. 82p. Available from Commission of the European Communities, Luxembourg.

Production delays associated with chain problems on armoured flexible conveyors (AFC's) currently account for approximately 3.5 minutes per shift in British Coal. In an attempt to reduce this figure an examination was made of the principal reasons for chain failure and a comprehensive programme of work was undertaken to assess the manner and extent of chain assembly deterioration in service using a combination of non-destructive, metallurgical and mechanical tests. No one test was found to supply all the information necessary to indicate the suitability of chain for further service or to predict residual life. However, a combination of on-site measurements and mechanical testing of samples taken periodically from the AFC chain assemblies can provide a satisfactory means of monitoring. The use of trend analysis of data plotted against a measure of work done by the assembly is an essential part of the monitoring process. Useful on-site measurements include chain 'stretch' i.e. interlink wear, numbers of links removed and connector pad wear. Useful tests on chain samples taken periodically include hardness, to check against specification, visual examination for gross damage and tensile testing to provide the Energy Absorption Factor (EAF). Because sprocket damage was found to be so significant it is recommended that effort be devoted to not only ensuring that sprockets meet their initial specification but also to seeking improvements in design, manufacture, and heat treatment to minimise wear and damage to both the chain and the sprocket. 10 refs., 21 tabs.

19212 (EUR-12168-ES) **Investigation, development and demonstration of an integrally mechanised method of exploitation in coal seams with dips of between 40 and 60 degrees.** Lago, R.; Margereto, J.; Luque, V.; Fuente, A.; Saez, E. HUNOSA, Mieres (Spain). 1989. 129p. (In Spanish). Available from Commission of the European Communities, Luxembourg.

The integral mechanization of semivertical and vertical coals seams with inclinations of 40-60° poses a problem which has not yet been satisfactorily solved. The aim of this project was to find equipment which helps to solve the problem. In cooperation with Westfalia-Luenen GmbH and Mackina Westfalia, 14 supports were designed and constructed for installation in an experimental face with a dip of 57° and mean thickness of 1.58m, located at Hunosa's Pozo Ma Luisa mine. The movement of the filling for different seam inclinations was also investigated, with the help of a scale model, a number of measurements on site and a computer program simulating its behaviour. This report describes the mining method used during the experiment and draws conclusions which permit the determination of conditions for future use of both the method and the equipment, as well as the features of the face to which these can be applied. The main conclusions are as follows: the method is feasible in seams ranging from between 0.90 and 2.20 m, with medium and even bad roofs, appropriate walls and minimum 500-600m length; with or without filling, failure of a considerable part of the roof occurs after the passing of the supports and for this reason a retreating method is recommended; covering of the roof must be increased; supports must be lightened and shortened and for seams of over 70° inclination, other modifications are probably needed.

19213 (EUR-12309-EN) **Condition monitoring of face support systems.** British Coal Corp., London (UK). 1989. 362p. Available from Commission of the European Communities, Luxembourg.

Powered roof support systems are large complex hydraulic machines and are essential to the operation of modern coalfaces. The main aim of the project was to develop methods of monitoring the condition of hydraulic powered support systems. The programme of work included development of techniques, evaluation and field trials. The main areas of work covered were: pressure deficiency

profile; optical liquid level detector; mine water pump monitoring; suction filter blockage; 60/40 emulsion monitoring; 5/95 emulsion monitoring; and pump monitoring. The report details the work undertaken on all the above work areas, the techniques developed and evaluated, and their testing, both in the laboratory and underground. The methods can be used to monitor the condition of powered support systems and the results can be used by engineering management at collieries so that maintenance and corrective action can be taken to remedy problems before failures and delays are caused. 24 refs., 92 figs., 46 tabs.

19214 (EUR–12310-DE) **Development of preliminary calculation methods for rock and earth movements allowing for current winning methods.** Klosta, G.; Paulekat, W.; Wagener, B.; Wagner, C. Bergbau-Forschung GmbH, Essen (Germany, F.R.). 1989. 126p. (In German). Available from Bergbau-Forschung GmbH, Essen (Germany, F.R.).

The project first involved an extensive review of technical literature in order to establish those calculation processes which permit a selection of different parameters. The three methods which display a representative cross-section of state-of-the-art theories (distribution function, profile curve and model theory) were subsequently defined, and for two of these programs were drawn up for application on colliery PCs. An analysis software was also developed for the collection and display of measurement data in a standard format. Examination of the results display showed that the data relating to only one measurement object was suitable for scientific investigation with various pre-calculation methods and for the determination of further parameters. Using measurement and calculation results, as carried out by Bergbau-Forschung, the potential applications for computer and graphic analysis were displayed and interpreted. The subsequent calculations undertaken as part of the project do not satisfy the requirements of a process for the preliminary calculation of ground settlement since they show excessive levels of discrepancy when compared with the measured rates of settlement. Only those calculations undertaken with the WIELAND process corresponded well with the measurement curves (after variation of different parameters). This positive solution has so far been restricted to relatively small working areas.

19215 (EUR–12311-EN) **Further work on control of deformation processes at longwall coal faces.** British Coal Corp., Stanhope Bretby (UK). Headquarters Technical Dept. 1989. 184p. Available from Commission of the European Communities, Luxembourg.

Research at the University College of Wales, Cardiff (UK) is described on the acquisition of data on coalface deformation during longwall mining, and on control measures which enable deformation processes to be accommodated within the context of high output longwall faces. The research has produced a new approach, integrating geotechnical survey with monitoring of strata and support system behaviour such that characteristic deformation processes have been identified. Recommendations are given concerning: support system design, support maintenance and operational techniques, panel layout, and coalface design. 15 refs., 81 figs., 34 tabs.

19216 (EUR–12313-DE) **Improved mine planning by anticipating deposit conditions on the basis of adjacent mine openings.** Skala, W.; Thomsen, A.; Arndt, R.; Lehmann, F.; Weber, V. Freie Univ. Berlin (Germany, F.R.). 1989. 65p. (In German). Available from Commission of the European Communities, Luxembourg.

Using EDP-assisted correlation methods based on artificial intelligence, this research project showed that as far as reception quality was concerned the above methods gave a relatively satisfactory performance, particularly when employing manually-set assignment lines in situations involving different parallelisation possibilities. The 'PARALL' system pioneered by Bergbau-Forschung in Essen is a mainframe programming system which provides a high level of differentiation. Though the inability to separate the knowledge base from the problem-solving components limits the expandability of this system, it was capable of accomplishing the tasks in question. The more-flexible PC programming system 'MATCH', which features a separate knowledge base, is suitable for refinement and development in respect of dialog capacity etc.

19217 (EUR–12314-FR) **Selecting a suitable powered-support design for thick-seam faces in inclined deposits.** Poirot, B. Centre d'Etudes et Recherches des Charbonnages de France (CERCHAR), 92 - Rueil-Malmaison (France). 1989. 100p. (In French). Available from Commission of the European Communities, Luxembourg.

Powered support design has kept pace with changes in seam thickness and face gradient. Load-bearing capacity has generally been increased to cope with the problems posed by strata stability. The research was conducted along two main lines: as thorough as possible an analytical approach, allowing for available facilities and underground conditions; and a global investigation using suitable statistical methods. On the basis of the results obtained it is now possible to re-examine the original findings and to put forward guidelines for the selection of powered roof supports commensurate with the type of roof beds being encountered. The two possible instances are as follows: (a) it is technically possible to envisage a load-bearing capacity which prevents roof breaking at the face line, transferring this to a point behind the supports; in this case the required support capacity can be calculated exactly; (b) it is impossible to prevent the formation of fissures at the coal face, the supports being called upon to support the resulting strata blocks; in this case conventional prediction methods are employed.

19218 (NERDDP-EG–89-810) **Optical fibre based gas sensing in coal mines.** Stuart, A.D.; Samson, P.J. National Energy Research, Development and Demonstration Council, Canberra (Australia). 1989. vp. Available from Department of Resources and Energy, GPO Box 858, Canberra, ACT 2601, Australia.

The project objectives were to identify the possible approaches that might be used for optical fibre sensing of gases, to assess more closely the approaches that were identified, to build a prototype system based on the most promising techniques and to test it at a coal mine. Three methods were assessed namely, Raman spectrometry, infrared spectrometry, and specific chemical sensors known as optrodes that have spectral changes in the presence of the gas of interest.

19219 (NERDDP-EG–89-821) **Development of a low cost semi-rigid permanent stopping system.** Davis, R.W.; Howlett, P.F.; Buizen, M. National Energy Research, Development and Demonstration Council, Canberra (Australia). 1989. vp. Available from Department of Resources and Energy, GPO Box 858, ACT 2601, Australia.

The objective of this project was to develop a low cost, semi-rigid ventilation stopping system for use in underground mine areas which suffer roof sag, floor heave, rib movement and general roadway convergence. Such deformable stoppings are desirable in both longwall and conventional mining panels where ground movement and convergence can damage or destroy conventional stoppings.

19220 (NERDDP-EG–89-838) **Investigation of wire rope fatigue and potential monitoring devices.** National Energy Research, Development and Demonstration Council, Canberra (Australia). 1989. vp. Available from Department of Resources and Energy, GPO Box 858, ACT 2601, Australia.

The objective of this project was to improve the accuracy with which the remaining fatigue life of dragline boom support ropes can be predicted. This would lead to savings in the cost of machine downtime for rope replacement, as well as in the cost of wasted rope life. At the same time the risk of unexpected failure in service can be reduced. The project investigated methods of condition monitoring for static support ropes based on measurements of length, elastic properties and acoustic emissions. Several potential monitoring methods were tested in laboratory trials. The tests confirmed the general observations on fatigue behaviour of wire ropes recorded in the literature.

0130 Transport, Handling, and Storage

19221 (CRIE-W–88015) **Study of CWM dry preparation systems.** Ono, Tetsuo; Koyata, Kazuo; Sakuta, Masayuki; Abe, Yoshihisa; Onodera, Hiroshi. Central Research Inst. of Electric

Power Industry, Tokyo (Japan). Mar 1989. 38p. (In Japanese). Order Number DE90753080. Available from NTIS (US Sales Only), PC A03/MF A01.

In CWM preparation using pulverized coal produced by dry-crushing, it is ordinarily difficult to turn the pulverized coal into CWM owing to its water repellency and the step requires a lot of time. Therefore, a preparation method which turns the pulverized coal into CWM by a jet current from the water-air mixed jet pump, was proposed and examined its possibility. Furthermore, basic design was made of CWM preparation unit using this method and evaluation of economy was carried out. The water-air mixed jet pump using in dredging work was utilized for the CWM dry preparation system, and the CWM preparation method through sucking the pulverized coal in the jet pump was proposed. An experiment on the CWM preparation was conducted using the small-sized jet pump, it was found that the CWM was prepared completely in a short time by a jet current. As the results of the economic evaluation based on the basic design of the unit with 200 MW * 2 capacity, it was revealed that the equipment cost is lower by about 30% than that of the wet preparation method and the preparation cost is also reduced by about a billion yen a year. 14 refs., 17 figs., 12 tabs.

19222 (DOE/PC/88951–4) **Determination of flow-regime boundaries for cohesive particles: Quarterly report, June 20–September 19, 1989.** Knowlton, T.M. Institute of Gas Technology, Chicago, IL (USA). Jan 1990. 45p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-88PC88951. Order Number DE90006792. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Recent research has shown that beneficiation of oil shale and coal is possible after grinding these materials down to the cohesive size range. The purpose of this work is to develop a hydrodynamic model capable of predicting the choking/non-choking flow regime boundary for cohesive solids. There are six tasks in this study: Preparation of Project Work Plan; Hydrodynamic Model Development; Determination of Solid Rheological Properties for Incorporation into the Hydrodynamic Model; Small-Scale Flow Tests; Large-Scale Flow Tests; and Comparison of Model with Data and Preparation of Final Report. This quarter, equations for the two-phase, gas-solids, dilute-phase flow of cohesive solids incorporating the kinetic theory of granular solids flow were used to calculate radial and axial solid and gas velocity distributions. Also, a feed hopper incorporating a feed screw and a novel pulsed-gas distributor was constructed. In Task 4, the construction of the small-scale (3-inch-diameter) riser test unit was completed. Initial shakedown tests were conducted with FCC catalyst using an x-ray densitometer to measure the radial solids distribution in the riser. Tests with an extraction probe were also conducted to determine the radial distribution of mass flux in the riser. 4 refs., 17 figs., 2 tabs.

19223 (DOE/PC/90957–T8) **Fluidization mechanisms in slurry flow.** Campbell, C.S. University of Southern California, Los Angeles, CA (USA). Dept. of Mechanical Engineering. [1989]. 59p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-86PC90957. Order Number DE90006497. Available from NTIS, PC A04/MF A01 - OSTI.

There are two mechanisms by which heavy settling particles may be suspended in a horizontal slurry flow: (1) by particle-particle interactions (e.g. Bagnold dispersive stresses) and (2) by particle-fluid interactions (e.g. entrainment of the particles by turbulent eddies.) The purpose of this investigation is to determine to what extent each fluidization mechanism is active and the effect of the fluidization mechanism on the global properties of the slurry. The technique employs the understanding that the particles entrained in the turbulence of the fluid will appear as an increased hydrostatic head across the channel. This may be directly measured and can be related to the fraction of the mass of particles that are supported by fluid-particle forces. (The rest must therefore be supported by particle-particle forces.) 17 refs., 26 figs.

19224 (EUR–11749-EN) **Improvements to coal transport methods and associated site reception and handling facilities for the industrial user.** British Coal Corp., Stoke Orchard (UK). Coal Research Establishment. 1989. 92p. Available from Commission of the European Communities, Luxembourg.

A comprehensive coal handling system, installed at CRE for receiving, storing and supplying coal to a test boilerhouse, has shown itself generally reliable and environmentally attractive. The system comprises coal reception by means of a 22 tonne tipping hopper and storage within two silos, one of flat-bottomed concrete stave (250 tonnes) construction and the other of glassed steel (160 tonnes) construction with a hopper bottom. Transfer of coal between these components and boiler feed hoppers is provided by a dense-phase pneumatic conveying system. In addition to the tipping hopper two further reception systems, containerisation and a wide belt vehicle unloader, have been investigated. Facilities developed to receive, unload and tip standard 20 tonne capacity ISO containers have been installed at a customer trial site. Tests with a 200 mm diameter suction nozzle have demonstrated that coal conveying rates of up to 61 tonne/hr can be achieved. The consequence of long term storage of smalls coal has been investigated during a storage period of 12 months within the concrete stave silo at CRE. During this period, the carbon monoxide concentrations in the silo headspace underwent considerable daily variation. This was found to be dependent upon atmospheric temperature, pressure and windspeed. Based on the principles derived from a test unit, a hydraulic ash sluicing system has been installed to transport oversize ash extracted from the bed of a 9 MWt fluidised bed furnace at an industrial site. A low-cost, submerged, rubber belt wet ash extraction system has been installed on a modular boilerhouse which was on test at CRE. This unit has undergone long-term evaluation trials and has been operated successfully during a nine-month trial period. The unit, together with the modular boilerhouse, is to be moved to a customer site and a second unit has been placed on order. 13 refs., 48 figs., 5 tabs.

19225 (EUR–12361-EN) **Coal degradation in mechanical handling transfer and conveying equipment for industrial plant.** British Coal Corp., Stoke Orchard (UK). Coal Research Establishment. 1989. 84p. Available from Commission of the European Communities, Luxembourg.

The project is directed towards establishing the factors affecting the nature and extent of size degradation of graded coals in transport systems used for industrial combustion plant. Results show that there was some degradation of coal during delivery, storage and handling which caused some problems in combustion or coal handling, due to excessive fines. Specific recommendations are made on the design of screw conveyors and pneumatic conveying systems. 23 refs., 25 figs., 18 tabs.

0140 Combustion

Refer also to citation(s) 19173, 19199, 19542, 20828

19226 (CONF-891113–11) **Pyrolysis of coal in the presence of air and limestone.** Goyal, A. (Institute of Gas Technology, Chicago, IL (USA)); Rehmat, A.; Van Hook, J.; Robertson, A. Institute of Gas Technology, Chicago, IL (USA). 1989. 33p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-86MC21023. From American Institute of Chemical Engineers annual meeting; San Francisco, CA (USA); 5-10 Nov 1989. Order Number DE90007578. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A computer model has been developed, based on data currently available in literature, to simulate air-blown pyrolysis of coal in a carbonizer. A calcium-based sorbent (limestone or dolomite) can also be fed simultaneously with coal to the carbonizer to capture in-situ sulfur released into the gas. In addition to capturing the sulfur, the sorbent also influences the product yields by cracking some tar to gases and soot. The char, soot, tar, spent sorbent, sulfur capture, air feed, and product gas flow rates and their compositions are determined by the computer model. This model has been used to predict carbonizer performance for two feedstocks, Pittsburgh No. 8 bituminous coal and Texas lignite at pressures of 14 and 10 atmospheres. Also, the effects of feedstock moisture content and operating temperature on the carbonizer performance have been studied for each feedstock and pressure. A coal-water slurry feed has also been considered for the bituminous coal. 21 refs., 14 figs., 6 tabs.

19227 (CRIE-W-88010) **Development of low-NOx and low-ignition loss combustion technology on pulverized coal combustion (Part 1). Low-NOx and low-ignition loss combustion by multi-stage air injection method.** Makino, Hisao; Kimoto, Masayoshi; Akiyoshi, Hisashi; Tanaka, Takashi. Central Research Inst. of Electric Power Industry, Tokyo (Japan). Dec 1988. 46p. (In Japanese). Order Number DE90753078. Available from NTIS (US Sales Only), PC A03/MF A01.

On the pulverized coal combustion in a coal-fired power plant, simultaneous reduction of NOx and combustible loss in fly ash by use of multi-stage air injection method has been studied. At the case of the single air port for two-stage combustion, when the rate of two stage combustion air is over 30%, the NOx concentration increases with the increase of the two stage combustion air, because of the increase of the NOx formation due to the re-burning at the air injection point. At the case of the multi air port for two-stage combustion, when the suitable separation of two-stage combustion air is used, the NOx concentration is reduced more than the case of single air port, because the re-burning at the air injection points is controlled. In the case of suitable multi stage air injection, the unburned carbon in fly ash is reduced to 18% at NOx concentration 100 ppm (in conventional two-stage combustion, the unburned carbon in fly ash is 30%). 5 refs., 21 figs., 10 tabs.

19228 (DOE/FC/10627-2799) **Ash deposition from low rank coals: Final report.** Austin, L.G.; Conn, R.E. Pennsylvania State Univ., University Park, PA (USA). Coll. of Earth and Mineral Sciences. Aug 1989. 231p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-85FC10627. Order Number DE90000461. Available from NTIS, PC A11/MF A01 - OSTI; GPO Dep.

A laboratory test furnace was utilized to investigate ash deposit initiation and build-up as related to pulverized coal (p.c.)-fired combustion systems. Vertical tube furnace ("drop-tube") investigations were conducted to study both ash deposition on heat transfer surfaces in a utility boiler and ash deposit formation on gas turbine hot gas pathways. In these tests, the rate of coal ash deposition and deposit strength were determined from coals ranging in rank from lignite to medium volatile bituminous. The presence of a low viscosity liquid phase in coal ashes has been shown to enhance the rate of deposit growth and deposit strength in both utility boilers and gas turbines. The objective of this work was to relate the rate of deposit formation and deposit strength from the test coals to their predicted ash viscosities. 79 refs., 56 figs., 33 tabs.

19229 (DOE/METC-90/6109) **Proceedings of the fifteenth biennial low-rank fuels symposium.** Ness, H.M. (ed.). USDOE Morgantown Energy Technology Center, WV (USA); North Dakota Univ., Grand Forks, ND (USA). Energy and Mineral Research Center. May 1989. 653p. Sponsored by U.S. DOE Fossil Energy. (CONF-890573--: 15. annual biennial low-rank fuels symposium, St. Paul, MN (USA), 22-25 May 1989). Order Number DE90000427. Available from NTIS, PC A99/MF A01 - OSTI; GPO Dep.

Research programs from the 15th biennial low-rank fuels symposium are presented. Major topics included: pulverized coal combustion; mining and resource assessment; ash deposition; flue gas cleanup; flue gas cleanup – research and development; clean coal technology; beneficiation; future for low-rank coals; alternate fuels; fluidized-bed combustion; conversion technology; coal conversion; emerging technology; perspectives on waste management; utility disposal; and waste utilization and reuse. Individual projects are processed separately for the data bases.

19230 (DOE/PC/79650-8) **CWS-fired residential warm-air heating system: Final report, January 22, 1987-July 31, 1988.** Balsavich, J.C.; Becker, F.E.; McPeak, M.A.; Smolensky, L.A. TECOGEN, Inc., Waltham, MA (USA). Sep 1988. 104p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-87PC79650. Order Number DE90007602. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

This report summarizes the results of the first phase of the research program devoted to the development of a coal-water slurry (CWS) fired residential warm-air heating system. The program plan was divided into three phases. During the first phase of the program, Tecogen Inc., developed key components of the furnace. The general component groups were: components that promote combustion processes and components directly related to these processes (combustion chamber, burner, and atomizer); a heat exchanger that transfers sensible heat to a circulating water loop; and a gas cleanup system. Two separate furnace systems were constructed and tested. At the heart of the furnace is a combustor that works on the principle of using centrifugal forces to internally separate and detain coal particles within hot precombustion chambers and thereby maximize residence time. The acronym IRIS, standing for Inertial Reactor with Internal Separation, was established for the combustor. The first IRIS combustor was of stainless steel construction and air cooled, with the objective being to verify the fundamental concept. A second proof-of-concept IRIS combustor was built with a water cooled outer shell and a high-temperature, refractory insulated inner liner. This second combustor achieved combustion efficiencies in excess of 99 percent while burning CWS. The unit was operated with input rates ranging from 60,000 to 240,000 Btu/hr. 167 refs., 45 figs., 3 tabs.

19231 (DOE/PC/79909-9) **Pyrite thermochemistry, ash agglomeration, and char fragmentation during pulverized coal combustion: Quarterly report, September 15, 1989-December 15, 1989.** Stanford Univ., CA (USA). Dept. of Mechanical Engineering. Jan 1990. 20p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-87PC79909. Order Number DE90007424. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

During p.f. firing of coal, the evolution of particulate ash from extraneous mineral matter is determined by thermochemistry, agglomeration of molten inclusions as the char is consumed, and fragmentation of the char into finer particulates. Our three-year research program aims for a fundamental understanding of these chemical and physical dynamics, to motivate control strategies for fouling and slagging problems. The transformation of pyrite inclusions into iron oxide ash is the primary focus, including pyrite thermochemistry, the average number of ash particles per char particle, and the relation between the size of distributions and composition of mineral inclusions and ash particles. Most of the quarter was devoted to modify an existing computer simulator to handle the Fe/O/S thermochemistry, but these aspects are reviewed very briefly in next section. Most of this report is devoted to comparisons among our results and reported values, with a particular emphasis on the sensitivity to the number of species included in the calculation. The pyrite phase diagram and iron oxide ash conversions are considered. Finally, the simulator was used to develop baseline information to compare with laboratory studies reported last quarter. 6 refs., 13 figs., 1 tab.

19232 (DOE/PC/88913-T3) **Mechanics/heat-tranfer relation for particulate materials: Quarterly report.** Campbell, C.S. University of Southern California, Los Angeles, CA (USA). Dept. of Mechanical Engineering. Jan 1990. 9p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-88PC88913. Order Number DE90006953. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

In this quarter, we have been working (1) on publishing our fluidized bed research, (2) development of the new particle-pressure transducer and (3) developing a computer control system for the heaters in the conductivity shear cell. Results are discussed. 3 figs.

19233 (ECN-89-187) **Pyrite transformations and slagging in a semi-industrial furnace.** Ten Brink, H.M.; Smart, J.P.; Hamburg, G.; Vleeskens, J.M. Netherlands Energy Research Foundation, Petten (Netherlands). Dec 1989. 4p. Available from Netherlands Energy Research Foundation ECN, P.O. Box 1, 1755 ZG Petten, Netherlands.

Whereas boiler slagging has been recognized as one of the most costly problems associated with pulverized coal combustion it is still a hardly understood phenomenon. The existing knowledge on slagging stems from observations and tests in full scale installation. Knowledge on mineral matter transformations on the other hand has been obtained from bench-scale experiments. In order to relate both types of data an experiment has been set up in a 2.5 MW semi-industrial boiler. Alumina and silicon carbide slag probes were inserted at characteristic sites in the boiler. The coal used was rich in pyrite. This choice was based on the fact that FeS_2 is nearly always involved in the reported cases of severe slagging. Conclusions are: pyrite transformations are those predicted from

bench-scale studies and the oxidation process is as fast as the oxidation of the coal; incompletely oxidized pyrite in the form of pyrrhotite (FeS) induces slag in the form of molten droplets, fully oxidized pyrite in the form of solid iron oxide does not adhere to surfaces; deposits on the quarl probe are similar to those on the burner-quarl of the furnace and to deposits in near-burner regions of full-sized furnaces. 2 figs., 8 refs.

19234 (IEACR–19) **Power generation from lignite.** Couch, G.R. IEA Coal Research, London (UK). c Dec 1989. 67p. Available from IEA Coal Research, 10-18 Putney Hill, London SW15 6AA, England.

Minemouth power generation is the principal use for lignite. This report describes the application of lignite to pulverized fuel firing, cyclone firing and fluidized bed combustion. Gasification of lignite is also discussed. Power plant design considerations such as storage, handling, milling, boiler design, ash deposition and emissions are considered. A chapter is devoted to fuel quality considerations. Experience of the combustion of lignite for power generation in Australia, the FRG, the GDR, Greece, Thailand and the USA is described. 86 refs., 60 figs., 26 tabs.

19235 (IE-MOEI–88/0100, pp. 106) **Counter-current flow for coal combustion.** Hazanov, Z. (Technion - Israel Inst. of Tech., Aeronautical Engineering Dept., (Haifa)); Goldman, Y.; Timnat, Y.M. Ministry of Energy and Infrastructure, Jerusalem (Israel). Jun 1988. (CONF-880609–: Energy 88: 2. International congress and exhibition on energy, Tiberias (Israel), 5-10 Jun 1988). In *Energy 88. The 2nd international congress and exhibition on energy. Abstracts.* Available from COSTI P.O.B 20125, TEL-AVIV 61201.

Abstract only.

The aim was to study the behavior of coal and ash particles in a counter-current flow combustor and to explore the practicability of high quality combustion at such a temperature that the ash would remain dry. Staging the oxygen supply and applying counter-current flow of the combustion products significantly improves the burning intensity. Practical limits are set by melting and sticking of the ash and by a possible NO_x formation increase at temperatures above 1400 degrees C. Reduction of flame temperature by combustor modifications and fuel consumption reduction reduced the total reaction extent and the volatiles reaction efficiency, but only marginally influenced the combustor performance. A 60% volume decrease led to a 35% reduction in volumetric combustion intensity. Small coal particles provide most of the volatiles in the first stage of the process, while, for particles larger than 74 micrometers, pyrolysis and the char homogeneous reaction overlap. The average particle size decreases during combustion. Ash separation from the hot gases was improved by using rotary motion of the combustion products before they leave the burning area. It was then found possible to collect about 80% of the total ash content. Chemical analysis indicated significant changes in the ash composition during combustion, and the appearance of low-melting constituents, which were mostly alkali oxides. Even low concentrations of these result in high adhesion and low rebounding of particles. (RP)

19236 (NERDDP-EG–89-816) **Modelling of ignition and combustion in swirl burners for pulverised coal.** Truelove, J.S.; Williams, R.G. National Energy Research, Development and Demonstration Council, Canberra (Australia). 1989. vp. Available from Department of Resources and Energy, GPO Box 858, ACT 2601, Australia.

The objective of this project was to apply the burner model developed at the University of Newcastle to interpret the Electricity Trust of South Australia pilot-scale and full-scale data on the ignition and combustion of brown coals, and to extrapolate the results to predict the performance of a full-scale burner fired on a new low-grade soft brown coal.

19237 (SAND–90-8209) **Coal combustion science quarterly progress report, July–September 1989.** Hardesty, D.R. Sandia National Labs., Livermore, CA (USA). Feb 1990. 77p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC04-76DP00789. Order Number DE90008113. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This activity consists of basic research on coal combustion that supports both the Pittsburgh Energy Technology Center (PETC) Direct Utilization Advanced Research and Technology Development Program, and the International Energy Agency (IEA) Coal Combustion Science Project. Specific tasks for this activity include: characterization of the physical and chemical processes that constitute the early devolatilization phase of coal combustion as a function of coal type, heating rate, particle size and temperature, and gas phase temperature and oxidizer concentration; characterization of the physical and chemical processes involved during coal combustion as a function of coal type, particle size and temperature, and gas phase temperature and oxygen concentration; and development of a quantitative understanding of the mechanisms and rates of transformation of mineral matter in coal combustion environments as a function of coal type, particle size and temperature, the initial forms and distribution of mineral species in the unreacted coal, and the local gas temperature and composition. A particular goal is determining the importance of fragmentation in the evolution of the particle size distribution during coal combustion. 41 refs., 18 figs., 7 tabs.

19238 **Mechanisms of coal-water mixture combustion in fluidized beds.** Gregory, J.W. (Iowa State Univ. of Science and Technology, Ames, IA (USA)); Brown, R.C. pp. 1382 of Proceedings of the 1989 international conference on fluidized bed combustion: FBC - technology for today. Fortner, J.G.; Rhoads, J.E. American Society of Mechanical Engineers, New York, NY (1989). (CONF-890404–: AAPG annual convention with DPA/EMD Divisions and SEPM, San Antonio, TX (USA), 23-26 Apr 1989).

The authors report their investigation of coal-water mixtures (CWM) as fuel for fluidized bed combustors (FBC). This fuel form may have distinct advantages compared to dry coal when fuel handling becomes an important consideration. For example, CWM may be useful in small industrial and commercial applications as well as in pressurized FBC. Previous studies of CWM have revealed distinct combustion behavior compared to combustion of dry coal. The objective of this research is to understand the mechanisms that control combustion of CWM in fluidized beds. The authors devised a series of tests to answer specific questions about the fundamental nature of CWM combustion. One experiment examines the hypothesis that CWM burns as both coal-sand agglomerates and char-flecked sand particles in a fluidized bed. A second experiment investigates the source of higher combustion efficiency for CWM compared to dry coal when these fuels are burned in a fluidized bed.

19239 **The development and application of scaling laws for a circulating fluidized bed package boiler.** Ake, T.R. (Riley Stoker Corp., Worcester, MA (USA)); Mongeon, R.K.; Breault, R.W.; Hall, A.W. pp. 1382 of Proceedings of the 1989 international conference on fluidized bed combustion: FBC - technology for today. Fortner, J.G.; Rhoads, J.E. American Society of Mechanical Engineers, New York, NY (1989). (CONF-890404–: AAPG annual convention with DPA/EMD Divisions and SEPM, San Antonio, TX (USA), 23-26 Apr 1989).

A circulating fluidized bed package boiler conceived for the small industrial market is being developed by testing a dynamically similar cold model. The cold model was built using scaling rules developed from two sets of dimensionless groups. The first set, found in recent literature, has been shown to successfully model fluidized bed combustors operating at 1140^{0}K. The other set, based on work in the 1950's, was developed to analyze inertial solids and gas separation systems such as cyclones and other dust collectors. In this study, the authors show that satisfying these two sets of dimensionless groups leads to one set of scaling rules for modeling the entire circulation loop of the package boiler.

19240 **Flow regime characterization of fossil fuel fluidized beds.** Rockey, J.M. (USDOE Morgantown Energy Technology Center, WV (USA)); Mei, J.S.; Nakaishi, C.V.; Robey, E.H. pp. 1382 of Proceedings of the 1989 international conference on fluidized bed combustion: FBC - technology for today. Fortner, J.G.; Rhoads, J.E. American Society of Mechanical Engineers, New York, NY (1989). (CONF-890404–: AAPG annual convention with DPA/EMD Divisions and SEPM, San Antonio, TX (USA), 23-26 Apr 1989).

This paper presents the results of experiments to characterize the various flow regimes and their transitions from fixed- to circulating fluidized-bed conditions conducted in a 0.3 m diameter, 6 m high fluidized bed operated at atmospheric temperature and pressure. Flow regime characteristics and their transition velocities for fluidized beds of large particles of different shapes and densities were examined through analysis of high-speed differential pressure and high-speed capacitance signal fluctuations. Signal frequency and amplitude distributions were analyzed using autospectral density techniques. This quantitative analysis was complemented with recorded visual observations.

19241 **The engineering and operating experience of firing coal-water slurries to the Grimethorpe pressurized fluidized-bed combustor.** Wright, S.J. (Grimethorpe PFBC Establishment, Grimethorpe, Barnsley, South Yorkshire (GB)); Fairclough, R.; Booth, B. pp. 1382 of Proceedings of the 1989 international conference on fluidized bed combustion: FBC - technology for today. Fortner, J.G.; Rhoads, J.E. American Society of Mechanical Engineers, New York, NY (1989). (CONF-890404--: AAPG annual convention with DPA/EMD Divisions and SEPM, San Antonio, TX (USA), 23-26 Apr 1989).

This paper discusses equipment designed and installed to prepare and fire to the pressurized fluidized-bed combustor a range of coal-water and coal-sorbent-water slurries. The design firing rate was 7 tons/hour of slurry. This paper describes the engineering and operating experience gained from the slurry preparation, transport and firing system. This experience is discussed in terms of its relevance to the design of full scale slurry firing systems.

19242 **Comparative performance of the Grimethorpe PFBC combustor when fed with dry coal and coal water mixtures.** Clark, R.K. (Grimethorpe PFBC Establishment, Grimethorpe, Barnsley, South Yorkshire (GB)); Wilks, I.H.C.; Burnard, G.K.; Weatherby, E.J.; Birkby, C. pp. 1382 of Proceedings of the 1989 international conference on fluidized bed combustion: FBC - technology for today. Fortner, J.G.; Rhoads, J.E. American Society of Mechanical Engineers, New York, NY (1989). (CONF-890404--: AAPG annual convention with DPA/EMD Divisions and SEPM, San Antonio, TX (USA), 23-26 Apr 1989).

The Grimethorpe pressurized fluidized bed combustion (PFBC) facility was operated for 550 hours between July and August 1987. During this period, the effect on the combustor performance of operating a low ash, high sulphur coal and sorbent feedstock as a coal-water mixture was assessed. The sorbent was fed in three different feed modes and the sulphur retention performance was monitored. The paper discusses combustor performance data to demonstrate the influence of a coal-water mixture feeding system compared to dry coal feeding. The paper illustrates the effect of process variables upon combustion and sulphur retention capabilities, gaseous emissions and discusses cyclone performance and heat transfer rates.

19243 **State-of-the-art computation of dynamics and erosion in fluidized bed tube banks.** Lyczkowski, R.W. (Argonne National Lab., IL (USA). Energy and Environmental Systems Div.); Folga, S.; Chang, S.L.; Bouillard, J.X.; Wang, C.S.; Berry, G.F.; Gidaspow, D. pp. 1382 of Proceedings of the 1989 international conference on fluidized bed combustion: FBC - technology for today. Fortner, J.G.; Rhoads, J.E. American Society of Mechanical Engineers, New York, NY (1989). DOE Contract W-31-109-ENG-38. (CONF-890404--: AAPG annual convention with DPA/EMD Divisions and SEPM, San Antonio, TX (USA), 23-26 Apr 1989).

Argonne National Laboratory's hydrodynamic and erosion modeling capabilities are summarized in this paper. Recent improvements in the hydrodynamic model, and the monolayer energy dissipation and Finnie erosion models are explained as is the implementation of the Neilson-Gilchrist model. Hydrodynamic results are presented and the erosion models are compared with each other for a generic two-dimensional few-tube approximation of a cold model fluidized bed combustor experiment as well as for single round and square tubes. Power spectral methods constituting means, autocorrelations, power spectral densities, variances and cross-correlations are used to analyze the hydrodynamic results and to attempt correlating them with the erosion patterns and rates. All of the erosion models predict order of magnitude agreement with each other and with limited erosion data.

19244 **Particle impact velocities and mass flux at fluidized bed tube surfaces in a cold flow model.** Drennen, J.F. (Combustion Engineering, Inc., Windsor, CT (USA)); Howard, D.A.; Hocking, W.R.; Botros, P. pp. 1382 of Proceedings of the 1989 international conference on fluidized bed combustion: FBC - technology for today. Fortner, J.G.; Rhoads, J.E. American Society of Mechanical Engineers, New York, NY (1989). (CONF-890404--: AAPG annual convention with DPA/EMD Divisions and SEPM, San Antonio, TX (USA), 23-26 Apr 1989).

Metal loss from in-bed heat transfer tubes in fluidized bed combustors is recognized by the U.S. Department of Energy (DOE) as an issue that is affecting the commercialization of FBC technology for coal utilization. Since the mechanism causing tube wastage has not been definitely identified, a program has been initiated by DOE to address the erosion aspect of the wastage problem. The objectives of the project are to develop a method for measuring the bed particle impact velocities and mass flux at a fluidized bed tube surface, to obtain wear data from simulated heat transfer tubes in an operating cold flow model, and to correlate the results. A probe capable of obtaining the three orthogonal velocity components and mass flux of impacting bed particles was developed during this project. Details of the probe design, operation, and test results are described in this paper.

19245 **Metal wastage in fluidized-bed combustors.** Podolski, W.F. (Argonne National Lab., IL (USA). Chemical Technology Div.); Reimann, K.J.; Swift, W.M.; Carls, E.L. pp. 1382 of Proceedings of the 1989 international conference on fluidized bed combustion: FBC - technology for today. Fortner, J.G.; Rhoads, J.E. American Society of Mechanical Engineers, New York, NY (1989). DOE Contract W-31-109-ENG-38. (CONF-890404--: AAPG annual convention with DPA/EMD Divisions and SEPM, San Antonio, TX (USA), 23-26 Apr 1989).

This paper presents an overview and status of a cooperative research joint venture on metal wastage in fluidized bed combustors. Tasks are being carried out in three main technical areas: hydrodynamic and erosion modeling, erosion monitor development, and experimental testing and model validation. The latter two areas are discussed in this paper.

19246 **Metallurgical characterization of wasted surfaces of in-bed carbon steel evaporator tubes.** Witherell, C.E. (Lawrence Livermore National Lab., CA (USA)). pp. 1382 of Proceedings of the 1989 international conference on fluidized bed combustion: FBC - technology for today. Fortner, J.G.; Rhoads, J.E. American Society of Mechanical Engineers, New York, NY (1989). DOE Contract W-7405-ENG-48. (CONF-890404--: AAPG annual convention with DPA/EMD Divisions and SEPM, San Antonio, TX (USA), 23-26 Apr 1989).

This study was conducted to characterize surfaces of carbon steel evaporator tubes from actual fluidized-bed coal combustors (FBC) with the objective of identifying wastage mechanisms and their causes. Observations suggest that tube material characteristics influence resistance to scale exfoliation in these environments. These characteristics include oxidation kinetics, scale-forming characteristics, and the role of steelmaking processes and alloying elements on properties of the scale, its adhesion and resistance to mechanical damage.

19247 **An advanced concept circulating fluidized bed combustor applicable to the industrial market.** Breault, R.W. (Riley Stoker Corp., Worcester, MA (USA)); Reicker, E.L.; Mongeon, R.K.; Hall, A.W. pp. 1382 of Proceedings of the 1989 international conference on fluidized bed combustion: FBC - technology for today. Fortner, J.G.; Rhoads, J.E. American Society of Mechanical Engineers, New York, NY (1989). (CONF-890404--: AAPG annual convention with DPA/EMD Divisions and SEPM, San Antonio, TX (USA), 23-26 Apr 1989).

Circulating fluidized bed combustor systems for industrial applications which can compete technically and economically with oil and gas fired boilers in the 46 to 92 kg steams/s (75,000 to 150,000 lb steam/hr) range are still in the development stages. This paper reports on a program to develop a circulating fluidized

bed system based on the multi-solids fluidized bed (MSFB) process which can compete with oil and gas fired boilers. The concept consists of the following systems: advanced MSFB boiler; coal and limestone receiving, storage, and feed systems; combustor and boiler control system; a particulate removal system; and ash storage and disposal system; and a stack. Each component has been optimized and modularized to meet, or exceed the contract objectives. The combustor has been optimized with respect to velocity, temperature, and volume.

19248 A relationship between solids recycling and sulphur retention in fluidized-bed combustors. Saroff, L. (USDOE Morgantown Energy Technology Center, WV (USA)); Zitterbart, M.T.; Ahart, A.K.; Hooper, H.M. pp. 1382 of Proceedings of the 1989 international conference on fluidized bed combustion: FBC - technology for today. Fortner, J.G.; Rhoads, J.E. American Society of Mechanical Engineers, New York, NY (1989). (CONF-890404--: AAPG annual convention with DPA/EMD Divisions and SEPM, San Antonio, TX (USA), 23-26 Apr 1989).

This paper reports on the relationship between sulfur retention and various operating parameters in fluidized-bed combustors (FBC) with and without ash recycling studied using reported data from FBC test facilities. An empirical equation developed to predict sulfur retention as a function of calcium-to-sulfur ration, bed residence time, bed temperature, and a sorbent reactivity constant is discussed. This correlation has been applied to predict sulfur retention for atmospheric fluidized-bed combustor (AFBC) and pressurized fluidized-bed combustor (PFBC) systems operating under various conditions. Based on these analyses, it appears that there exists a threshold recycle rate above which variations in feed calcium-to-sulfur ratios do not significantly change sulfur retention.

19249 Load turndown in a two-bed fluidized combustor. Brown, R.C. (Iowa State Univ. of Science and Technology, Ames, IA (USA). Dept. of Mechanical Engineering); Foley, J.E.; Buttermore, W. pp. 1382 of Proceedings of the 1989 international conference on fluidized bed combustion: FBC - technology for today. Fortner, J.G.; Rhoads, J.E. American Society of Mechanical Engineers, New York, NY (1989). (CONF-890404--: AAPG annual convention with DPA/EMD Divisions and SEPM, San Antonio, TX (USA), 23-26 Apr 1989).

The objective of the research discussed in this paper is to investigate a new concept in bubbling fluidized bed design that improves load turndown capability. This design consists of a central combustion bed surrounded by an annular fluidized bed that establishes overall heat-transfer rate from the combustion bed. The authors have constructed a laboratory-scale version of this two-bed combustor and are testing its performance when burning three fuel forms of Illinois No. 5 coal: 9.5 mm by 2.36 mm crushed coal, coal-water-limestone mixtures, and coal-limestone briquettes. In tests with crushed coal, they have achieved a load turndown of 12.3. These experimental results are found to compare favorably with predictions of a computer model that simulates heat transfer in the combustor.

19250 A novel laboratory test procedure for studying in-bed erosion: Design and some early results. . MacAdam, S. (Lawrence Berkeley Lab., CA (USA)); Levy, A.; Stringer, J. pp. 1382 of Proceedings of the 1989 international conference on fluidized bed combustion: FBC - technology for today. Fortner, J.G.; Rhoads, J.E. American Society of Mechanical Engineers, New York, NY (1989). (CONF-890404--: AAPG annual convention with DPA/EMD Divisions and SEPM, San Antonio, TX (USA), 23-26 Apr 1989).

A laboratory apparatus used to study in-bed erosion in fluidized bed combustors (fbc's) has been designed and tested. The procedure is based on the belief that a major cause of in-bed tube wear in bubbling beds is related to the interactions of the bubbles themselves with tubes. The collapse of bubbles or voids on tube undersides is known to throw what are essentially local regions of defluidized bed material up against tube bottoms with great force. This hammering effect is simulated within the test apparatus by repeatedly driving a specimen rod quickly downward a short distance within a minimally fluidized bed. The frequency, velocity, and other characteristics of the rod actuation are controlled to mimic the behavior of passing bubbles or collapsing voids observed in actual fbc's. Results of the initial cold characterization are presented. They indicate that this procedure subjects the specimen rod to pulsed forces similar to those experienced by fbc tubes, and that the resulting rod erosion is similar in both magnitude and circumferential distribution to that suffered by tubes in other studies that utilized conventional cold model beds.

0150 Economic, Industrial, and Business Aspects

Refer also to citation(s) 19185, 19278, 19701, 19703, 19714, 19716

19251 (DOE/EIA-0121(89/3Q)) **Quarterly coal report, July-September 1989.** USDOE Energy Information Administration, Washington, DC (USA). Office of Energy Markets and End Use. 8 Feb 1990. 149p. Sponsored by U.S. DOE Management & Administration. Order Number DE90007350. Available from NTIS, PC A07/MF A01 - GPO - OSTI; GPO Dep.

The Quarterly Coal Report provides comprehensive information about US coal production, exports, imports, receipts, consumption, and stocks to a wide audience, including Congress, Federal and State agencies, the coal industry, and the general public. This issue presents detailed quarterly data for July through September 1989, aggregated quarterly historical and projected data for 1981 through 1991, and aggregated annual historical and projected data for 1960 through 2000. 7 figs., 37 tabs.

19252 (DOE/FE/61811-T1) **[Potential for thermal coal and clean coal technology (CCT) export in the Asia-Pacific]: Quarterly technical progress reports, [February 21, 1989-May 20, 1989, May 21, 1989-August 20, 1989, August 21, 1989-November 20, 1989, November 21, 1989-February 20, 1990].** Fesharaki, F. East-West Center, Honolulu, HI (USA). Energy Program. Feb 1990. 21p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG03-89FE61811. Order Number DE90007194. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

It is the intent of this paper to review the outlook for the oceanborne thermal coal market in 2000 and provide projections of import and export flows that will satisfy global import demand, given technical, economic, and geographical supply constraints. Some broad strategies for coal exporters and importers will be discussed based on the findings of this paper. 8 tabs.

0160 Health and Safety

19253 (CRIEPI-U-88069) **Effects of coal fly ash inhalation on enzyme activities in the pulmonary alveolar macrophage.** Nishimura, I. (and others). Central Research Inst. of Electric Power Industry, Tokyo (Japan). 1989. vp. (In Japanese). Available from Central Research Institute of Electric Power Industry, Tokyo, Japan.

Alveolar macrophage (AM) phagocytizes the irritant inhaled into the lung alveoli. Phagocytic activity of AM depends upon an energy-generating system including oxidative phophorylation and glycolytic pathway in the cell. The purpose of this paper is to clarify the change of marker enzyme activity in that system during particle inhalation in vivo. Studies of forty eight male golden hamsters exposed to coal ash at 5 mg/m^3, 20 hours per day, for 10 days, and the same number of animals serving as control, showed that the enzyme activity of phagocytic activity of AM in the whole lung rose compared to the control. These results suggested that the newly activated AM was supplied by cell division or infiltration during exposure.

02 PETROLEUM

Refer also to citation(s) 20432

0202 Reserves, Geology, and Exploration

Refer also to citation(s) 19275

19254 (DOE/EH-0134) **Technical Safety Appraisal of the Naval Petroleum Reserve No. 1, Elk Hills, California.** USDOE Assistant Secretary for Environment, Safety, and Health, Washington, DC (USA). Feb 1990. 94p. Sponsored by U.S. DOE

Environment Health & Safety. Order Number DE90006375. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This report presents the results of a focused Technical Safety Appraisal (TSA) of the Naval Petroleum Reserve No. 1 (NPR-1), Elk Hills, California, conducted during November 27 through December 8, 1989. The Department of Energy (DOE) program organization responsible for NPR-1 is the Assistant Secretary for Fossil Energy (FE); the responsible Field Office is the Naval Petroleum Reserves California (NPRC) Office. This appraisal is an application of the program that was initiated in 1985 to strengthen the DOE Environment, Safety and Health Program. The appraisal was conducted by the staff of the DOE Assistant Secretary for Environment, Safety and Health (EH), Office of Safety Appraisals, with support from experts in specific appraisal areas, including a number from the petroleum industry, and a liaison representative from FE. The Senior EH Manager for the appraisal was Mr. Robert Barber, Acting Director, Office of Compliance Programs; the Team Leader was Dr. Owen Thompson, Office of Safety Appraisals.

19255 (DOE/IE–0016) **Strategic Petroleum Reserve: Analysis of size options.** USDOE, Washington, DC (USA). Feb 1990. 125p. Sponsored by U.S. DOE Management & Administration. Order Number DE90006328. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

This report presents the results of the deliberations of the interagency group formed to study the costs and benefits of expanding the size of the SPR. The study concentrated on severe oil supply disruptions involving sharp reductions in world oil production that were 2 to 4 times larger than the largest 1970s interruption. The disruption sizes and estimated probability of occurrence of these scenarios were supplied by the CIA. The most critical part of the CIA's analysis was the assessment of likelihood of these cases occurring. The CIA approached the likelihood problem by combining an examination of past oil supply disruptions with qualitative analysis of important oil market and regional trends. The study group then used statistical techniques and probability distributions to synthesize the historical data with CIA evaluations of as yet unobserved events. The SPR size study assumed direct purchases of SPR oil and did not assume the use of alternative financing mechanisms. Members of the working group with foreign policy and national security responsibilities provided an in-depth review of strategic considerations affecting SPR size. A number of prior studies, some classified, have addressed the strategic importance and insurance value of the SPR to the US and its allies. The results of these studies have also been incorporated in the current effort. 10 refs., 5 figs.

19256 (JNOC–8901) **Annual report (1988). Technical Research Center, Japan National Oil Corporation.** Japan National Oil Corp., Tokyo (Japan). 30 Jun 1989. 344p. (In Japanese). Order Number DE90753073. Available from NTIS (US Sales Only), PC A15/MF A01.

Technical Research Center, Japan National Oil Corporation published annual report, collecting the results of researchs, technical services, education, and international cooperations in the 1988. The main subjects of the successfull results of the researchs are as follows: Course of formation and growth of sedimentary baisn, analizing technology on reservoir rock formation process, crude oil and elementary rock comparison technology, surface geochemical exploration technology, high resolution data proccesing technology, seismic exploration technology utilizing S-curve, geophisical exploration technology for difficult exploration areas, geophisical exploration technology for petroleum reservoir structure, oil and natural gas foundation geologic survey in Antarctic Region, oil reservoir simulation technology, microorganism EOR technology, high precise oil reservoir eavaluation technology, heavy crude oil recovery increase technology, 2nd and 3rd recovery technology, well stimulation technology, production improvement measure, steeply slanting well drilling technology, real time drilling control technology, small scale ocean oil field developement technology, production technology for high temperature and corrosive environment, etc. 249 figs., 55 tabs.

19257 (LBL–28171) **Audio-frequency electromagnetic tomography for reservoir evaluation.** Zhou, Qiang. Lawrence Berkeley Lab., CA (USA). Oct 1989. 175p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90007347. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

The detection and characterization of major fracture zones, whether natural or manmade, is vital for petroleum production in fractured reservoirs. It is also of great importance for the proper storage of radioactive waste in waste repositories or for the efficient extraction of geothermal energy from geothermal reservoirs. The fracture zones or faults encountered in these applications serve as hydrological pathways along with the crude oil, geothermal energy, or radionuclides migrate. The purpose of this research is to assess the feasibility of detection and mapping of the fracture zones with a cross-hole electromagnetic technique since these saline fluid filled zones are usually at great depth and are electrically more conductive than the host rock. But, the presence of fractures makes the inference of reservoir properties from electromagnetic measurements much more difficult than would be the case in a conventional isotropic medium. The variations in fracture characteristics, such as size, orientation and others, are so complex that the full description of a reservoir may require other complementary methods. 105 refs., 70 figs.

19258 (NEI-NO–101, pp. 24) **Experiences in drilling of horizontal wells.** Jourdan, A.; Baron, G.A.; Wittrisch, C.; Armessen, P. Norsk Petroleumsforening, Oslo (Norway). 1983. (CONF-8310456– : 1. Northern European drilling conference, Kristiansand (Norway), 24-26 Oct 1983). In *First Northern European drilling conference, Kristiansand, Norway, October 24-26, 1983.* Order Number DE90748476. Available from NTIS (US Sales Only), PC A21/MF A01.

The paper deals with a research program on the drilling of horizontal wells. Four wells are logged and completed. Three onshore wells were drilled in France, and one offshore well has been drilled in the Italian Adriatic Sea. Following are details on how these wells were planned, and logged. Also included is the description of a new technique for getting logging tools to bottom in these highly deviated wells. 6 figs., 2 tabs.

19259 (NEI-NO–101, pp. 19) **Pressure determination and techniques for handling of shallow gas from floating rigs.** Nyvik, R. (Saga Petroleum a.s., Hoevik (Norway)). Norsk Petroleumsforening, Oslo (Norway). 1983. (CONF-8310456–: 1. Northern European drilling conference, Kristiansand (Norway), 24-26 Oct 1983). In *First Northern European drilling conference, Kristiansand, Norway, October 24-26, 1983.* Order Number DE90748476. Available from NTIS (US Sales Only), PC A21/MF A01.

The paper discusses some alternatives regarding pressure determination and techniques for the handling of shallow gas from floating rigs. Shallow gas problems must be solved to make the drilling operation safe and prevent expensive well killing operations. Once drilling a well it is known by gas chromatograph and logs if the formation contains shallow gas or not. The pressure, however, could be very difficult to determine. Particulary in the top hole and until the 20" casing is cemented where the height of fluid column vary by disconnecting the riser etc. This reduction of the hydrostatic pressure has to be replaced or a confirmation has to be made to ensure that the reduced pressure still is within safe limits. 4 figs.

19260 (NEI-NO–101, pp. 9) **Developments of methods for handling od shallow gas including future technology.** Bessey, K. Norsk Petroleumsforening, Oslo (Norway). 1983. (CONF-8310456–: 1. Northern European drilling conference, Kristiansand (Norway), 24-26 Oct 1983). In *First Northern European drilling conference, Kristiansand, Norway, October 24-26, 1983.* Order Number DE90748476. Available from NTIS (US Sales Only), PC A21/MF A01.

The paper considers a typical installation procedure for wellheads and casings, also the equipment to be used in these operations both at present and in the near future. The design and philosophy of new equipment and approaches to allow safe drilling into pressurized surface zones are discussed. One of the most hazardous aspects of drilling for surface casings during exploration drilling, is the presence of surface gas. Where sufficient preparation has not been made allow for this occurance, the results can

be catostrophic. Surface gas is defined as depositions of gas, entrapped in very young marine strata. This is characterized by high volume and low pressure discharges, and flow into the well bore at high feed rates. 6 figs.

19261 (NIPER–444) **Using image analysis to determine petrophysical properties of reservoir rocks.** Tomutsa, L; Brinkmeyer, A. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Mar 1990. 18p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC22-83FE60149. Order Number DE90000222. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The objective of this work is to apply computer image analysis methods to measurements of pore and grain parameters in reservoir rocks and to use the measured values of these parameters to predict petrophysical properties such as porosity, permeability, and capillary pressure. By computer image analysis, rapid measurements of pore and grain diameters, areas, and perimeters can be performed, and from these measurements various other parameters, such as shape factor, form factor, and specific surface can be derived. A commercially available PC-based image analysis system previously adapted for computations of petrophysical properties has been improved. Based on pore and pore throat measurements, rapid and reliable predictions of porosity, permeability, grain size distribution, and capillary pressure can be made from thin sections fabricated from rock samples as small as drill cuttings. 9 refs., 11 figs., 3 tabs.

19262 (OPI–CE-02852, pp. 20) **Trenton (Ordovician) structure in northwestern Ohio.** Wickstrom, L.H. (Ohio Dept. of Natural Resources, Columbus, OH (USA)). Ontario Petroleum Inst., Inc., Chatham, ON (Canada). 1988. (CONF-8810463–: 27. annual conference of the Ontario Petroleum Institute Inc, London (Canada); 23-25 Oct 1988; CE–02852). In *Twenty-seventh annual conference [of the] Ontario Petroleum Institute Inc.* Available from PC Ontario Petroleum Institute, Inc., 70 Talbot Road South, Box 340, Lambeth, ON, CAN N0L 1S0; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $35.00 CAN; MF $10 CAN.

A study is presented of rock structures in the Ohio portion of the Lima-Indiana oil and gas trend, which consists of over 60 fields and pools and which was extensively drilled in the late 1800's and early 1900's. Its purpose is to show where future exploration might be feasible. It is proposed that during the Ordovician, forces of the Taconic orogeny caused movement along a number of these zones. Movement along the Auglaize, Logan-Hardin, and Union Faults may have established the platform margin of the Trenton Limestone, the Sebree Trough, and the northwestern boundary of the Point Pleasant Basin. Many of the oil and gas fields constituting the prolific Lima-Indiana trend were located along these faults, especially along the platform margin of the Trenton adjacent to the Auglaize Fault system. This report is the result of an investigation conducted for the Ohio Department of Natural Resources, Division of Geological Survey. 26 refs., 9 figs.

19263 **Combination drilling and skiving tool.** Stone, W.J. To US Dept. of Energy, Washington, DC. USA Patent 4,869,625. 26 Sep 1989. Filed date 30 Sep 1988. USA Patent Application 7 251,485. Int. Cl. B23B 51/08. 6p. Available from Patent and Trademark Office, Box 9, Washington, DC 20232.

This patent describes a combination drilling and skiving tool including a longitudinally extending hollow skiving sleeve slidably and concentrically mounted on a right-handed twist drill. Dogs or pawls provided on the internal periphery of the skiving sleeve engage with the helical grooves of the drill. During a clockwise rotation of the tool, the drill moves downwardly and the sleeve translates upwardly, so that the drill performs a drilling operation on a workpiece. On the other hand, the drill moves upwardly and the sleeve translates downwardly, when the tool is rotated in a counterclockwise direction, and the sleeve performs a skiving operation. The drilling and skiving operations are separate, independent and exclusive of each other.

0203 Drilling and Production

Refer also to citation(s) 19256, 19274, 19275, 19276, 19277, 19286, 20073, 20114, 20115

19264 (DOE/BC–89/2) **Contracts for field projects and supporting research on enhanced oil recovery: Progress review No. 58, quarter ending March 31, 1989.** USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Office of Oil, Gas and Shale Technology; USDOE Bartlesville Project Office, OK (USA). 1989. 101p. Sponsored by U.S. DOE Fossil Energy. Order Number DE89000763. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

Research programs on enhanced recovery are briefly described. Major areas include: chemical flooding, gas displacement, thermal recovery processes, resource assessment technology, geoscience technology, microbial technology, and environmental technology.

19265 (DOE/BC/10846–T1) **Modelling and scale-up of chemical flooding: Quarterly report, January 1988–March 1988.** Pope, G.A.; Lake, L.W.; Sepehrnoori, K. Texas Univ., Austin, TX (USA). Dept. of Petroleum Engineering. [1988]. 20p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-85BC10846. Order Number DE90007262. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The objective of this research is to develop, validate, and apply a comprehensive chemical flooding simulator for chemical recovery processes involving surfactants, polymers, and alkaline chemicals in various combinations. This integrated program includes components of laboratory experiments, physical property modelling, scale-up theory, and numerical analysis as necessary and integral components of the simulation activity. Experimental data on the trapping of oil, brine, and microemulsion as well as some new relative permeability data are as follows: (1) Additional single-phase displacement data for two-phase, type II(−) and three-phase micellar solutions. (2) New single-phase displacement data for a two-phase, type II(+) surfactant formulation. (3) New and revised two-phase flow relative permeability data using type II(+) environment surfactant formulation. These were performed on two different core samples and at two different capillary numbers. (4) New data on residual microemulsion saturation for two-phase flow of brine and oil (excess-phases). 10 refs., 11 figs.

19266 (NEI-NO–101) **First Northern European drilling conference.** Norsk Petroleumsforening, Oslo (Norway). 1983. 491p. (CONF-8310456–: 1. Northern European drilling conference, Kristiansand (Norway), 24-26 Oct 1983). Order Number DE90748476. Available from NTIS (US Sales Only), PC A21/MF A01.

The collected papers presented at a conference discuss water pollution abatement and safety concerning directional well drilling operation and production on offshore sites. Fields like shallow gas problems, well logging procedures, development and use of oil-based muds, and also measures to prevent blowout as considered. Separate abstracts are prepared for all of the papers. 175 figs., 41 tabs., 49 refs.

19267 (NEI-NO–101, pp. 15) **Shallow gas in the Gullfaks area.** Lukkien, H.B. (Statoil, Bergen (Norway)). Norsk Petroleumsforening, Oslo (Norway). 1983. (CONF-8310456–: 1. Northern European drilling conference, Kristiansand (Norway), 24-26 Oct 1983). In *First Northern European drilling conference, Kristiansand, Norway, October 24-26, 1983.* Order Number DE90748476. Available from NTIS (US Sales Only), PC A21/MF A01.

The paper discusses the presence of shallow gas sands (pockets) in the Gullfaks area on the Norwegian continental shelf. Included are sections outlining a theory explaining the shallow gas phenomenon, the predictive technique and the mechanism which may cause the gas to escape from its reservoir. A graphical technique is used to clarify situations and conditions down-hole. This technique consists of a plot of depth versus pressure and shows the behaviour of various fluid- and gas columns expressed in gradients. Loss in hydrostatic head, reduction of the necessary over-balance and static pressure conditions which threaten to exceed formation integrity values, cement shear strength, etc. can be easily predicted. If the potential for gas flow, gas percolation, etc.

can be demonstrated by this graphical method, preventive techniques and procedures may be introduced during the planning and program stage which would dictate the final requirements for safe operations during the drilling- and production phase. 12 figs., 1 tab.

19268 (NIPER–458) **Development of an inflow performance relationship (IPR) for a slanted/horizontal well: Final report.** Cheng, A.M. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Mar 1990. 49p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC22-83FE60149. Order Number DE90000224. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Since 1968, the Vogel equation has been used extensively and successfully for analyzing the inflow performance relationship (IPR) of flowing oil wells under solution-gas drive. Oil well productivity can be rapidly estimated using the Vogel IPR curve and well outflow performance. However, the Vogel curve was originally developed for conventional vertical wells and may not be valid for slanted and horizontal wells. This report presents the development of IPR's for slanted and horizontal wells by using a vertical/horizontal/slanted well reservoir simulator. The generated IPR's are found to be similar to the parabolic characteristic of the Vogel curve. Several application examples are included to illustrate the use of the newly generated curves. 12 refs., 15 figs., 25 tabs.

19269 Analysis of horizontal-well performance by scaled physical modeling and numerical simulation. Ying, N.H. Thesis (Ph. D.). vp.Univ. of Southern California, Los Angeles, CA (US) (1988).

Steam flooding of heavy oil formations can be economical. Horizontal wells located at the bottom of a reservoir of extensive length increase the area exposed to the steam. This may well slow the rapid steam flow and release more heat at the steam-oil interface. A considerable role may be played by gravity drainage and imbibition, which will improve the efficiency of steamflooding. Few laboratory model studies of steam injection with horizontal wells, to examine recovery from reservoirs with extremely high oil viscosity, have been conducted. A scaled physical model was developed to inspect the producing mechanism of horizontal wells and was useful in obtaining much quantitative information. The partial support of SBIR/DOE permitted the design and construction of a most desirable physically scaled model for the investigation of such a mechanism during the steamflood processes. A three-dimensional generalized numerical simulation model named All Purpose Simulation of Thermal Recovery Operations (ASTRO) was applied to the design and analysis of this steam project. This model was processed by the IBM-3090 computer at the Union Oil Science and Technology Division. The results were used to analyze production performance in steam injection for both horizontal and vertical wells. Considerable improvement in performance was shown using horizontal wells in reservoirs containing moderately viscous oil as well as in those containing extremely heavy oil. This research has suggested that such processes will extend the applicability of steam injection for the recovery of truly viscous crudes and bitumens.

0204 Processing

Refer also to citation(s) 19180

0205 Products and By-Products

19270 (PB–90-854944/XAB) **Recycled materials in asphalt pavements. October 1973-November 1989 (Citations from the NTIS data base). Report for October 1973-November 1989.** National Technical Information Service, Springfield, VA (USA). Dec 1989. 62p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning the recycling of asphalt-pavement materials, and the use of other recycled materials to manufacture asphalt pavement. Articles discuss methods used for recycling bituminous pavement including hot-mix and cold-mix. Materials used to improve recycled pavement, and recycled materials used in asphalt pavement include latexes, rubber scrap such as tires, glass shards, concretes, dusts, waste oils, roofing wastes, sulfur, and metal refining sludges. Testing and evaluation of recycled pavements both in laboratories and in test cases are considered. (Contains 110 citations fully indexed and including a title list.)

19271 (PB–90-855024/XAB) **Aviation-fuel additives. January 1970-December 1989 (Citations from the NTIS data base). Report for January 1970-December 1989.** National Technical Information Service, Springfield, VA (USA). Dec 1989. 121p. Available from NTISPC N01/MF N01.

Supersedes PB–89-853055.

This bibliography contains citations concerning research and development of aviation-fuel additives, together with pertinent characteristics. Included are studies on antioxidants, antimist, antistatic, lubricity, corrosion inhibition, and icing inhibition additives. Other characteristics are covered in investigations into additives for vulnerability reduction, thermal stability, and storage stability of aviation fuels. (This updated bibliography contains 212 citations, 22 of which are new entries to the previous edition.)

0206 Health and Safety

Refer also to citation(s) 19254, 19259, 19260, 19266, 19267, 20073, 20106, 20108, 20114, 20115

19272 (EGG–10617-1039) **Effectiveness of water spray mitigation systems for accidental releases of hydrogen fluoride: Volume 5, Appendix G, Aerosol measurements.** Holve, D.J. (INSITEC, San Ramon, CA (USA)); Harvill, T.L. EG and G Energy Measurements, Inc., Las Vegas, NV (USA); Industry Cooperative Hydrogen Fluoride Mitigation/Assessment Program (USA). Water Spray Subcommittee; INSITEC, San Ramon, CA (USA). Jun 1989. 113p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC08-88NV10617. Order Number DE90007136. Available from NTIS, PC A06/MF A01 - OSTI.

This report is one of several work products generated by the Industry Cooperative HF Mitigation/Assessment Program. This ad hoc industry program began in late 1987 to study and test techniques for mitigating accidental releases of hydrogen fluoride (HF) and alkylation unit acid (AUA) and to better estimate ambient impacts from such releases. The hazards of HF have long been recognized. Standards operating practices focused on minimizing the possibility of a release and mitigating the effects if a release should occur. These practices are continually monitored and improved to maximize safety protection based on the available technical data. This recent program targeted further improvements based on new technical data. 142 figs.

19273 (EGG–10617-1041) **Effectiveness of water spray mitigation systems for accidental releases of hydrogen fluoride: Summary report.** Schatz, K.W. (Mobil Research and Development Corp., New York, NY (USA)); Koopman, R.P. Industry Cooperative Hydrogen Fluoride Mitigation/Assessment Program (USA). Water Spray Subcommittee. Jul 1989. 34p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC08-88NV10617. Order Number DE90007137. Available from NTIS, PC A03/MF A01 - OSTI.

Accidental releases of pressurized, superheated hydrogen fluoride (HF) can result in initially dense clouds which will typically contain a mixture of HF vapor, aerosol, and droplets. Previous experiments were performed by Amoco Oil Company and Lawrence Livermore National Laboratories (the Goldfish series in 1986) to study atmospheric dispersion of these HF clouds. The present study examines the effect of water application on the mitigation of these clouds. To assess the effectiveness of water application (via either sprays or monitor) in mitigating HF clouds two series of tests were conducted in separate flow chambers. Bench scale experiments identified key variables for testing in a larger facility. The larger scale field tests demonstrated that HF releases can be mitigated with water. The impact of numerous design variables on mitigation effectiveness has also been quantified. HF removal efficiencies of 25 to 90+% have been demonstrated at water to HF liquid ratios of 6/1 to 40/1 and higher. 6 refs., 22 figs., 2 tabs.

19274 (NEI-NO–101, pp. 27) **Blowouts - A computer simulation study.** Thomas, D.C.; Lea J.F. Jr. Norsk Petroleumsforening, Oslo (Norway). 1983. (CONF-8310456–: 1. Northern European drilling conference, Kristiansand (Norway), 24-26 Oct 1983). In *First Northern European drilling conference, Kristiansand,*

Norway, October 24-26, 1983. Order Number DE90748476. Available from NTIS (US Sales Only), PC A21/MF A01.

The paper deals with a computer simulation study of blowouts. A computer simulation study of blowouts was made using a program written earlier. This study shows the predicted effects of various sized kicks on a given welbore configuration and studies the major variables affecting kick severity in both water- and oil-based muds. The variables include reservoir variations (pressure, permeability, porosity, temperature) and pumping rate at the surface. Results are shown for the effects of each of these variables on an uncontrolled kick. The present program does not include control procedures but does include some examples of flow through a choke. It was intended to show what might happen if no control procedures were initated and to study the lower limits of kick detectability. Practices are suggested that should make earlier detection of a kick possible so that conventional kill procedures will be more effective. Blowout simulations suggest that pit gain is the most reliable indicator of a kick. It is recommended that pit level measurement systems, capable of detecting a pit gain of less than 5.0 barrels in the entire active mud system, be developed and be used where high pressure kicks are common. 20 figs., 7 tabs., 8 refs.

19275 (NEI-NO–101, pp. 19) **Driller's cabin and his functions: An integrated safety problem.** . Netland, K. (Rogaland Research Institute/Rogaland Regional College, Stavanger (Norway)). Norsk Petroleumsforening, Oslo (Norway). 1983. (CONF-8310456–: 1. Northern European drilling conference, Kristiansand (Norway), 24-26 Oct 1983). In *First Northern European drilling conference, Kristiansand, Norway, October 24-26, 1983.* Order Number DE90748476. Available from NTIS (US Sales Only), PC A21/MF A01.

The paper discusses safety problems in exploration drilling. Following aspects are considered: Human behaviour and function; research programme concerning the Driller's functions and his control room; background and experimental set-up; data technology and Driller's control system; preliminary results and future controlroom. 10 figs.

19276 (NEI-NO–101, pp. 22) **Presentation of Statoil computerized drilling data system.** Magnussen, T. (Norske Stats Oljeselskap A.S., Stavanger (Norway)); Dyrseth, A. Norsk Petroleumsforening, Oslo (Norway). 1983. (CONF-8310456–: 1. Northern European drilling conference, Kristiansand (Norway), 24-26 Oct 1983). In *First Northern European drilling conference, Kristiansand, Norway, October 24-26, 1983.* Order Number DE90748476. Available from NTIS (US Sales Only), PC A21/MF A01.

The paper deals with the development of a computerized drilling data system beeng made on the data gathering techniques like well logging, sampling, testing, mud logging, and measurement - while - drilling. The main purpose of collecting all the data is to investigate the possible prospects, and to obtain an acceptable level of safety. A third application is the possibility these data create regarding further operational improvements and increased efficiency. The system also includes the computer code BORIS covering a complete system for data maintenance and reporting of information regarding the drilling operations and adjacent areas.

19277 (NEI-NO–101, pp. 9) **BOP system test philosophy - testing frequency - elastomer developmemt.** Just, F.E. Norsk Petroleumsforening, Oslo (Norway). 1983. (CONF-8310456–: 1. Northern European drilling conference, Kristiansand (Norway), 24-26 Oct 1983). In *First Northern European drilling conference, Kristiansand, Norway, October 24-26, 1983.* Order Number DE90748476. Available from NTIS (US Sales Only), PC A21/MF A01.

The paper deals with the test philosophy concerning the safety of BOP (Blowout prevention) systems, and focuses on the fields of testing frequency and elastomer development. The BOP system is the safety device that directly protects the life of the rig crew, the drilling rig and the surrounding environment. The BOP system must be in first class operating condition at all times while installed on the wellhead. To insure maximun BOP system reliability, the system must be tested regularly and frequently. How frequently is the question here.

0207 Economic, Industrial, and Business Aspects

Refer also to citation(s) 19255, 19701, 19703, 19714, 19716

19278 (DOE/EIA–0206(88)) **Performance profiles of major energy producers, 1988.** USDOE Energy Information Administration, Washington, DC (USA). Office of Energy Markets and End Use. 26 Jan 1990. 159p. Sponsored by U.S. DOE Management & Administration. Order Number DE90006865. Available from NTIS, PC A08/MF A01 - GPO - OSTI; GPO Dep.

The financial performance of the major energy companies in 1988 was remarkable for the break in the link between the course of oil prices and financial results. Although oil prices declined in 1988, nearly matching the lows of 1986, net income of the FRS companies nearly doubled and their capital expenditures rose by more than 40 percent from the prior year. Performance Profiles of Major Energy Producers 1988 is the twelfth annual report of the Energy Information Administration's (EIA) Financial Reporting System (FRS). During the period encompassed by the FRS data base, 1974 through 1988, the energy industry has responded to a wide variety of unsettling forces. This report examines the responses of the 23 major energy companies who report to the FRS to developments in energy and capital markets in 1988. The FRS companies play a major role in US energy markets. In 1988, they accounted for nearly 60 percent of US oil production and reserves, nearly 80 percent of US refined product output, and nearly 90 percent of US-based companies' foreign investment in petroleum. For the FRS companies, the year 1988 contained many notable developments, including: income from downstream petroleum (refining, marketing, and transport) reached a record level; for the first time over the 1974 through 1988 period of FRS data collection, the nonenergy line of business contributed more to net income than did oil and gas production; the FRS companies' US exploration and development expenditures rose dramatically, reflecting heightened offshore exploration activity, higher drilling costs, and merger and acquisition activity; the FRS companies' US drilling emphasized natural gas exploration. Their US natural gas reserve additions reached a 15-year high; and although changes in corporate structure continued, charges against income for restructuring dropped sharply from the levels of recent years. 32 refs., 116 tabs.

19279 (DOE/EIA–0380(89/11)) **Petroleum marketing monthly, November 1989.** USDOE Energy Information Administration, Washington, DC (USA). Office of Oil and Gas. 7 Feb 1990. 185p. Sponsored by U.S. DOE Management & Administration. Order Number DE90007123. Available from NTIS, PC A08/MF A01 - GPO - OSTI; GPO Dep.

The Petroleum Marketing Monthly (PMM) is designed to give information and statistical data about a variety of crude oils and refined petroleum products. The publication provides statistics on crude oil costs and refined petroleum products sales for use by industry, government, private sector analysts, educational institutions, and consumers. Data on crude oil include the domestic first purchase price, the f.o.b. and landed cost of imported crude oil, and the refiners' acquisition cost of crude oil. Sales data for motor gasoline, distillates, residuals, aviation fuels, kerosene, and propane are presented. 12 figs., 49 tabs.

0208 Waste Management

Refer also to citation(s) 19722, 19723, 19807, 19808, 20278

19280 (EGG–10617-1037) **Effectiveness of water spray mitigation systems for accidental releases of hydrogen fluoride: Volume 3, Appendix E: Water spray test data.** Schatz, K.W. (Mobil Research and Development Corp., New York, NY (USA)); Koopman, R.P. Industry Cooperative Hydrogen Fluoride Mitigation/Assessment Program (USA). Water Spray Subcommittee. Jun 1989. 203p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC08-88NV10617. Order Number DE90007140. Available from NTIS, PC A10/MF A01 - OSTI.

This report is one of several work products generated by the Industry Cooperative HF Mitigation/Assessment Program. This ad hoc industry program began in late 1987 to study and test techniques for mitigating accidental releases of hydrogen fluoride (HF)

and alkylation unit acid (AUA) and to better estimate ambient impacts from such releases. The hazards of HF have long been recognized. Standard operating practices focused on minimizing the possibility of a release and mitigating the effects if a release should occur. These practices are continually monitored and improved to maximize safety protection based on the available technical data. This recent program targeted further improvements based on new technical data.

19281 (HAZ–CE02855) **Haztech Western Canada '88: Hazardous waste management and environmental control conference proceedings.** Haztech Canada, Edmonton, AB (Canada). 1988. 387p. (CONF-8810478–: Haztech western Canada: hazardous waste management and environmental control conference, Edmonton (Canada), 5-6 Oct 1988; CE–02855). Available from Haztech Canada, 4936-87th St., no. 26, Edmonton, AB, CAN T6E 5W3. Prices: $50.00 CAN.

This conference dealt with the management of hazardous materials, particularly hazardous wastes. The focus is mainly on the petroleum and natural gas industries, particularly the province of Alberta. Among the subjects covered are the processing and disposal of wastes, the transport and storage of hazardous materials, safety procedures and legislation, and emergency plans. Other subjects included are the chemical analysis of wastes, the dangers of asbestos, mercury and lead, and indoor air Separate abstracts have been prepared for 9 papers from this conference.

19282 (HAZ–CE02855, pp. 296-303) **Special waste issues for the petrochemical industry.** Wurster, D. (Alberta Gas Ethylene, Red Deer, AB (Canada)). Haztech Canada, Edmonton, AB (Canada). 1988. (CONF-8810478–: Haztech western Canada: hazardous waste management and environmental control conference, Edmonton (Canada), 5-6 Oct 1988; CE–02855). In *Haztech Western Canada '88: Hazardous waste management and environmental control conference proceedings.* Available from Haztech Canada, 4936-87th St., no. 26, Edmonton, AB, CAN T6E 5W3. Prices: $50.00 CAN.

The guidelines of the Canadian Chemical Producers Association are summarized in this paper. The role of the industry in the regulatory process in Alberta is outlined. The results of a nationwide public opinion poll about the perception of industrial risks are recalled. Recycling, lists of hazardous materials, and efforts for the reduction of waste (including the planned Swan Hills facility in Alberta) are briefly discussed. The conclusion was drawn that the industry must improve its public image, support the reduction, reuse, recycling and recovery of waste, and continue to cooperate in the development of legislation and regulations. A list of acronyms pertaining to pollution end waste management included

0209 Environmental Aspects

Refer also to citation(s) 19264, 19272, 19273, 19280, 19281, 20355, 20357, 20386

19283 (AD-A–214349/3/XAB) **Environmental impacts of oil and hazardous-material spills with emphasis on winter conditions in the upper Great Lakes region. Final report.** Baca, B.J.; Lankford, T.E.; Gundlach, E.R. Coastal Science and Engineering, Inc., Columbia, SC (USA). Nov 1986. 67p. Available from NTIS, PC A04/MF A01.

The purpose of this report is to summarize available literature on the effects of oil and related hazardous materials on freshwater organisms, concentrating on winter (ice) conditions. A comprehensive review of various other hazardous materials was not the purpose of this report since toxicological information on a myriad of substances is available from the Environmental Protection Agency (EPA) and from the manufacturers.

19284 (CONF-8809413–Exec.Summ.) **Environmental and public health effects of soils contaminated with petroleum products: Executive summary.** Massachusetts Univ., Amherst, MA (USA). Dept. of Public Health. [1988]. 13p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract FG01-88EH79082. From 3. national conference on the environmental and public health effects of soils contaminated with petroleum products; Amherst, MA (USA); 19-21 Sep 1988. Order Number DE90006502. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The goal of the conference organizers of the Third National Conference on the Environmental and Public Health Effects of Soils Contaminated with Petroleum Products was to provide common ground and a forum for regulated and regulatory communities to meet and present new information, exchange ideas, and focus and refine the nature of scientific and regulatory problems. The conference provided state-of-the-art information on the whole array of PCS issues including: analytical methodologies; environmental fate; remedial options; environmental and pubic health impacts; regulatory approaches.

19285 (HAZ–CE02857, pp. 426-440) **Comprehensive site remediation CSR™ anchored by bioreclamation saves groundwater supply of small mid Atlantic community.** Yaniga, P.M. (Groundwater Technology, Inc. Chadds Ford, PA (USA)); Aceto, F.; Fournier, L.; Matson, C. Haztech Canada, Edmonton, AB (Canada). 1989. (CONF-8905280–: Haztech Canada Toronto '89: environmental control/hazardous waste management conference, Mississauga (Canada), 16-18 May 1989; CE–02857). In *Haztech Canada Toronto '89: Environmental control/hazardous waste management conference proceedings.* Available from Haztech Canada, 4936-87th St., no. 26, Edmonton, AB, CAN T6E 5W3. Prices: $50.00 CAN.

A small community in northeastern Pennsylvania used the Comprehensive Site Remediation process to save its drinking water supply wells from hydrocarbon contamination. The contamination occurred in January 1985. Approximately 1,000 gal of regular leaded gasoline leaked from a 20-year-old underground storage tank at the Borough's Public Water Works, 50 ft from one of the supply wells. All three wells and all water pumps were shut down after the discovery of the leak. The first step of restoration was the removal of the tank and the determination of the extent of the contamination. After the plume was defined, a 6 in recovery well was installed and the pumping of the contaminated water began; in addition, an aeration apparatus was constructed. The water was stripped/treated for dissolved constituents and discharged into a local surface stream. However, only less than 15% of the total contamination could be recovered in this way. Since excavation of the contaminated ground was not, in this case, feasible, a biodegradation program was designed and implemented in order to reduce soil-absorbed and dissolved hydrocarbons, using both biodegradation and standard pump-and-treat technology. Microbiologists, after designing and piloting the nutrient mix program, began adding hydrogen peroxide and nutrients to the contaminated water to enhance the natural degradation process. A July 1987 examination of dissolved hydrocarbons showed nearly complete remediation of soil and ground water. 4 figs., 1 tab.

19286 (NEI-NO–101, pp. 22) **Cuttings separation and processing with oil based muds.** Anon. Norsk Petroleumsforening, Oslo (Norway). 1983. (CONF-8310456–: 1. Northern European drilling conference, Kristiansand (Norway), 24-26 Oct 1983). In *First Northern European drilling conference, Kristiansand, Norway, October 24-26, 1983.* Order Number DE90748476. Available from NTIS (US Sales Only), PC A21/MF A01.

The paper deals with cuttings separation and processing with oil-based muds. The major design criteria requirements for equipment choice is outlined. An integrated solids separation and cuttings cleaning system developed for an arctic condition is described. 8 figs., 1 tab.

19287 (PB–90-129701/XAB) **Synthesis of knowledge of the potential impacts of OCS (Outer Continental Shelf) oil and gas activities on fisheries.** Technical Resources, Inc., Rockville, MD (USA). Oct 1989. 2136p. Available from NTIS, PC EE99/MF E99.

Set includes PB–90-129719 through PB–90-129776.

A separate abstract is included for each of the 7 reports of this set.

19288 (PB–90-129719/XAB) **Synthesis of knowledge of the potential impacts of OCS (Outer Continental Shelf) oil and gas activities on fisheries. Executive summary. Final report.** Tear, L.M. Technical Resources, Inc., Rockville, MD (USA). Oct 1989. 9p. Available from NTIS, PC A02/MF A01.

See also PB–90-129727; Also available in set of 7 reports PC E99, PB–90-129701.

The purpose of this report is to summarize the existing knowledge concerning the distribution and relative abundance of select species of finfish and shellfish along the coasts of the United States. The species selected for review include those of particular commercial, recreational, and/or ecological importance. The appendices to the report present annotated bibliographies of studies and data bases concerning the distribution and relative abundance of target species and of studies concerning the potential impacts of OCS oil and gas activities on finfish and shellfish species and fishery resources.

19289 (PB–90-129727/XAB) **Synthesis of knowledge of the potential impacts of OCS (Outer Continental Shelf) oil and gas activities on fisheries. Technical summary. Final report.** Tear, L.; Beadle, H. Technical Resources, Inc., Rockville, MD (USA). Oct 1989. 6p. Available from NTIS, PC A02/MF A01.

See also PB–90-129719 and PB–90-129735; Also available in set of 7 reports PC E99, PB–90-129701.

This report summarizes the existing knowledge concerning the distribution and abundance of selected species of finfish and shellfish along the coasts of the United States. The appendices to the report present annotated bibliographies of studies related to the distribution and abundance of these species and of studies concerning the potential impacts of OCS oil and gas activities on fisheries.

19290 (PB–90-129735/XAB) **Synthesis of knowledge of the potential impacts of OCS (Outer Continental Shelf) oil and gas activities on fisheries. Volume 1. Distribution and relative abundance of select target species. Final report.** Tear, L.M.; Beadle, H. Technical Resources, Inc., Rockville, MD (USA). Oct 1989. 536p. Available from NTIS, PC A23/MF A03.

See also PB–90-129727 and PB–90-129743; Also available in set of 7 reports PC E99, PB–90-129701.

The purpose of the report is to summarize the existing knowledge concerning the distribution and relative abundance of select species of finfish and shellfish along the coasts of the United States. The species selected for review include those of commercial, recreational, and ecological importance. Discussions of the species apparent distribution and relative abundance, apparent historical trends in distribution and abundance patterns, and gaps in existing information are presented for each species. Maps are also included that depict the species adult distributions along the coasts of the United States.

19291 (PB–90-129743/XAB) **Synthesis of knowledge of the potential impacts of OCS (Outer Continental Shelf) oil and gas activities on fisheries. Volume 1. Appendix, annotated bibliography, and data base descriptions for target species, distribution and abundance studies. Section 1, Part 1. Final report.** Tear, L.M. Technical Resources, Inc., Rockville, MD (USA). Oct 1989. 476p. Available from NTIS, PC A21/MF A03.

See also PB–90-129735 and PB–90-129750; Also available in set of 7 reports PC E99, PB–90-129701.

The purpose of the appendix is to present an annotated bibliography of published and grey literature related to the distribution and abundance of select species of finfish and shellfish along the coasts of the United States. The volume also includes descriptions of databases that contain information related to target species distribution and abundance. An index is provided at the end of each section to help the reader locate studies or data bases related to a particular species.

19292 (PB–90-129750/XAB) **Synthesis of knowledge of the potential impacts of OCS (Outer Continental Shelf) oil and gas activities on fisheries. Volume 1. Appendix, annotated bibliography and data base descriptions for target species, distribution and abundance studies. Section 1, Part 2. Final report.** Tear, L.M. Technical Resources, Inc., Rockville, MD (USA). Oct 1989. 423p. Available from NTIS, PC A18/MF A03.

See also PB–90-129743 and PB–90-129768; Also available in set of 7 reports PC E99, PB–90-129701.

The purpose of the appendix is to present an annotated bibliography of published and grey literature related to the distribution and abundance of select species of finfish and shellfish along the coasts of the United States. The volume also includes descriptions of data bases that contain information related to target species distribution and abundance. An index is provided at the end of each section to help the reader locate studies or data bases related to a particular species.

19293 (PB–90-129768/XAB) **Synthesis of knowledge of the potential impacts of OCS (Outer Continental Shelf) oil and gas activities on fisheries. Volume 1. Appendix, annotated bibliography and data base descriptions for target species, distribution and abundance studies. Section 2. Final report.** Tear, L.M. Technical Resources, Inc., Rockville, MD (USA). Oct 1989. 110p. Available from NTIS, PC A06/MF A01.

See also PB–90-129750 and PB–90-129776; Also available in set of 7 reports PC E99, PB–90-129701.

The purpose of the appendix is to present an annotated bibliography of published and grey literature related to the distribution and abundance of select species of finfish and shellfish along the coasts of the United States. The volume also includes descriptions of data bases that contain information related to target species distribution and abundance.

19294 (PB–90-129776/XAB) **Synthesis of knowledge of the potential impacts of OCS (Outer Continental Shelf) oil and gas activities on fisheries. Volume 2. Appendix, annotated bibliography for ocs oil and gas impact studies. Final report.** Tear, L.M. Technical Resources, Inc., Rockville, MD (USA). Oct 1989. 576p. Available from NTIS, PC A25/MF A03.

See also PB–90-129768; Also available in set of 7 reports PC E99, PB–90-129701.

The purpose of the appendix is to present an annotated bibliography of published and grey literature related to OCS oil and gas activity impacts to finfish and shellfish in marine and estuarine waters. An index is provided to help the reader locate studies related to a particular impact.

0210 Legislation and Regulations

Refer also to citation(s) 19272, 19273

0220 Transport, Handling, and Storage

Refer also to citation(s) 19690, 20070

0230 Properties and Composition

Refer also to citation(s) 19192

03 NATURAL GAS

Refer also to citation(s) 20432

0302 Reserves, Geology, and Exploration

Refer also to citation(s) 19262, 19931, 20520

19295 (DOE/MC/22009–2785) **Thermal modeling of forearc regions: Final report.** Kominz, M.A.; Bond, G.C. Columbia Univ., Palisades, NY (USA). Lamont-Doherty Geological Observatory. Aug 1989. 231p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-85MC22009. Order Number DE90000434. Available from NTIS, PC A11/MF A01 - OSTI.

The unconventional natural gas resource program of the Department of Energy has targeted ancient subduction zones as a possible source of organic-origin natural gas. The suggestion is that organic sediments which have been accreted in the prism and/or subducted beneath the prism will produce gas at greater depths than in more conventional, generally hotter, basins. A critical element in determining the likelihood of gas generation in ancient or modern accretionary prisms is the thermal regime of the accreting prism. We have developed a computer model to determine the overall thermal regime in the modern forearcs of Oregon/Washington and southern Alaska. This allows us to predict the likelihood that gas has been generated at depth in the forearc prism,

or within sediments as they are subducted beneath the prism. In fact, the model results indicate that subduction and accretion of these sediments at low temperatures increases the probability that ancient subduction zones, once accreted to the craton and allowed to heat in response to migration of the volcanic front, could be the source of natural gas. 75 refs., 24 figs.

19296 (PB–90-129958/XAB) **Well report. CNG Development Company, United Affiliates Corporation No. 2814. GRI (Gas Research Institute) Comprehensive Study Well No. 3, Logan County, West Virginia. Topical report, February 1988–January 1989.** Lowry, P.H.; Hamilton-Smith, T.; Falleur, J.P.; Peterson, R.M. K and A Energy Consultants, Inc., Tulsa, OK (USA). Jan 1989. 54p. Available from NTIS, PC A04/MF A01.

This report explains the geology and gas-producing mechanisms of the CNG Development Co., U.A.C. No. 2814 well (CSW No. 3) based on the regional geology, analysis of nearby well data and production characteristics of the well. Gas production from the Devonian Shales of southwestern West Virginia depends on a combination of unusual geological factors, some of which are not easily identified. Although almost 3 tcf of gas have been produced from the Big Sandy Field and several thousand wells drilled, noneconomical wells are frequently drilled in the field and there is still no generally accepted model to aid in the siting of wells. CSW No. 3 did not test significant gas reserves in the Devonian Shales, probably due to the lack of trap development at that location. There are numerous faults in the Devonian age and older rocks and folds in younger rocks which indicate the potential for extensive fracturing in the CSW No. 3 area. Abundant Mississippian Berea gas production coincides with flexure over the Warfield Fault, but relatively minor Devonian Shale production is localized and generally does not show a correlation to the fault, suggesting a complex gas migration and trapping environment.

19297 (PB–90-129966/XAB) **Well report. Columbia Natural Resources, Inc. Pocahontas Development Corporation No. 21680. GRI (Gas Research Institute) Comprehensive Study Well No. 1, Martin County, Kentucky. Topical report, October 1987-August 1988.** Hamilton-Smith, T.; Lowry, P.; Peterson, R.M.; Falleur, J. K and A Energy Consultants, Inc., Tulsa, OK (USA). Aug 1988. 28p. Available from NTIS, PC A03/MF A01.

This report explains the geology and gas-producing mechanisms of the C.N.R. PDC No. 21680 well (CSW No. 1) based on the regional geology, analysis of nearby well data and production characteristics of the well. Gas production from the Devonian shales of eastern Kentucky depends on a combination of unusual geological factors, some of considerable subtlety. Although almost 3 tcf of gas have been produced from the Big Sandy field and several thousand wells drilled, dry holes are frequently drilled in the field and there is still no generally accepted model to aid in the location of wells. CSW No. 1 production is probably due to intersection of fracture systems with a distinctive lithological contrast at the base of the Middle Huron. These fracture sets were produced by reactivation of basement faults.

0303 Drilling, Production, and Processing

Refer also to citation(s) 19266, 19274, 19275, 19276, 19277, 20073, 20114, 20115

19298 (DOE/METC–90/4095-Vol.1) **Potential of infill drilling to increase Devonian shale gas reserves in the Appalachian Basin: Volume 1, Kanawha County, West Virginia, case study.** Layne, A.W. USDOE Morgantown Energy Technology Center, WV (USA). Jan 1989. 56p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90000447. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This report presents results of two studies to evaluate the potential of infill drilling as a gas production strategy in the Devonian shales. This case study (Volume 1), completed in West Virginia, compares actual field data with simulations. Infill wells were placed in an existing field in an area of high flow capacity (determined by history matching). Results indicate that 50 percent more gas may be recovered over a 10-year period if infill wells are drilled in the more geologically favorable area of a field. Geologically favorable areas of a field are locations where high permeability and thickness have been calculated through history matching. A simplified economic analysis was performed to determine feasible infill scenarios. A Devonian-gas-shale economics model was used to evaluate the results of both studies. Required gas prices were calculated for a 20 percent rate-of-return on investment for each infill drilling scenario. Results determined that less than 80-acre well spacing was not economically feasible. A reduced number of wells spaced 80 acres or more apart was productive, in agreement with the state-wide study (Volume 2). Accordingly, areas in West Virginia and Kentucky are candidates for infill drilling, but such areas of high flow capacity can only be found through a detailed geologic characterization with history matching. 15 refs., 42 figs., 8 tabs.

19299 (DOE/METC–90/4095-Vol.2) **Potential of infill drilling to increase Devonian shale gas reserves in the Appalachian Basin: Volume 2, Ohio, Kentucky, and West Virginia.** Layne, A.W. USDOE Morgantown Energy Technology Center, WV (USA). Jan 1989. 11p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90000448. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report presents results of two studies to evaluate the potential of infill drilling as a production strategy in the Devonian shales. This study (Volume 2) uses data evolved during the Eastern Gas Shales research program to compile gas-in-place estimates and to analyze key production mechanisms. Each of the three states was partitioned into areas based on key geological parameters and tectonophysics that established the natural stress and fracture regimes. Within these partitioned areas, a simulation study of infill drilling was conducted to determine the impact of reduced well spacing on 40-year cumulative gas production. In this approach, one, three, and five infill wells were randomly located in a field of five existing wells that had been producing for 20 years. After 20 years of well production, the well recovery for each simulated infill well was evaluated. 5 figs., 5 tabs.

19300 Fluid flow in healed tectonic fractures. Morrow, N.R. (Petroleum Recovery Research Center (US)); Brower, K.R.; Ma, S.; Buckley, J.S. pp. 550 of Proceedings of the SPE gas technology symposium: Serving a competitive market. Society of Petroleum Engineers, Richardson, TX (1989). (CONF-890644–: Society of Petroleum Engineers gas technology symposium: gas technology serving a competitive market, Dallas, TX (USA), 7-9 Jun 1989).

Technical Paper SPE 19096.

Inspection of core samples recovered during the course of the MWX experiment revealed the presence and likely abundance of vertical tectonic fractures which have become mineralized. These fractures are believed to contribute significantly to gas production. The fractures are usually only up to a few millimeters in width and are mostly calcite-filled. Permeability measurements, both along and across the fractures, show that the mineralized fractures were more permeable than the surrounding matrix, but the differences in measured permeabilities were usually well within an order of magnitude. The conductivity of mineralized fractures relative to the matrix was confirmed by a novel type of tracer experiment which provided a record of the distribution of gas flow at the outlet end of the core. Relative permeability measurements show that mineralized fractures make an increasingly significant contribution to gas flow with increase in water saturation.

19301 Production strategies for tight gas sands: A case study of the Upper Cozzette blanket sand. . Bezilla, M. (Pennsylvania State Univ. (US)); Adewumi, M.A.; Ertekin, T.; Sung, W.; Frohne, K.H. pp. 550 of Proceedings of the SPE gas technology symposium: Serving a competitive market. Society of Petroleum Engineers, Richardson, TX (1989). (CONF-890644–: Society of Petroleum Engineers gas technology symposium: gas technology serving a competitive market, Dallas, TX (USA), 7-9 Jun 1989).

Technical Paper SPE 19108.

The authors discuss the importance of the role that natural gas from tight formation would play in achieving energy self-sufficiency for the United States. However, the technology for recovering this resource remains elusive, primarily due to lack of adequate understanding of the physics of fluid flow dynamics within this type of porous media. It is believed that tight formations frequently possess dual porosity, and the flow field in these formations may be

governed by more than one mechanism.The model utilized in this study possesses predictive capabilities, and is used as a framework for the development of optimal production strategies for the Upper Cozzette blanket sand. The model has multi-well capabilities and has options for either vertically or horizontally fractured wells and horizontal boreholes. Simulation results from a variety of production schemes are presented. The results provide some insight into production strategies involving horizontal boreholes and hydraulic fractures.

0305 Health and Safety

Refer also to citation(s) 19266, 19274, 19275, 19276, 19277, 20073, 20106, 20108, 20114, 20115

0306 Economic, Industrial, and Business Aspects

Refer also to citation(s) 19278, 19701, 19703, 19716, 19839

19302 (CONF-8905185–1) **Use of videos for Distribution Construction and Maintenance (DC&M) training.** Long, G.M. Institute of Gas Technology, Chicago, IL (USA). [1989]. 7p. Sponsored by Institute of Gas Technology. From American Gas Association Operating Section Distribution/Transmission conference; New Orleans, LA (USA); 21-24 May 1989. Available from OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616.

This paper presents the results of a survey taken among members of the American Gas Association (AGA)'s Distribution Construction and Maintenance (DC&M) committee to gauge the extent, sources, mode of use, and degree of satisfaction with videos as a training aid in distribution construction and maintenance skills. Also cites AGA Engineering Technical Note, DCM-88-3-1, as a catalog of the videos listed by respondents to the survey. Comments on the various sources of training videos and the characteristics of videos from each. Conference presentation included showing of a sampling of video segments from these various sources. 1 fig.

19303 (ESC-WR–89-23) **European gas demand prospects to 2010.** Van Oostvoorn, F.; Van der Linden, N.H. Stichting Energieonderzoek Centrum Nederland, Petten (Netherlands). Energie Studie Centrum. Dec 1989. 20p. Available from Netherlands Energy Research Foundation ECN, P.O. Box 1, 1755 ZG Petten, Netherlands.

To evaluate the impacts of some recent events in the European gas market on the natural gas demand two long term gas demand scenarios are developed. The low gas demand scenario reflects today's EC gas market practices and thinking, in which current pricing rules, trade barriers etc., are prolonged till 2010. Subsequently, the low gas demand (LGD) scenario represents views, opinions and thus demand estimates showing a limited scope for further gas penetration in the EC. However the high gas demand (HGD) scenario, incorporates the impacts from the Single Market directives, which will enforce harmonization of (energy) taxes and prices, price transparency, open access to national and international pipeline systems, and very stringent pollution abatement policies. Consequently more efficient trading and transport and thus lower relative gas prices for the end users in the HGD scenario will result. Severe measures to abate SO_2 and NO_x etc., will add substantially to an end user's pricing in favour of natural gas. Both scenarios are based on almost similar key assumptions, such as imported crude oil prices, annual growth rates of population, GDP, industrial production etc. In general both scenarios can be characterized as low energy demand scenarios. 2 figs., 15 refs., 7 tabs.

0307 Waste Management

Refer also to citation(s) 19281, 19723, 19807, 20278

19304 (HAZ–CE02855, pp. 26-41) **An analytical protocol for the analysis of gas plant wastes.** Birkholz, D. (Enviro-Test Labs., Edmonton, AB (Canada)). Haztech Canada, Edmonton, AB (Canada). 1988. (CONF-8810478–: Haztech western Canada: hazardous waste management and environmental control conference, Edmonton (Canada), 5-6 Oct 1988; CE–02855). In *Haztech Western Canada '88: Hazardous waste management and environmental control conference proceedings.* Available from Haztech Canada, 4936-87th St., no. 26, Edmonton, AB, CAN T6E 5W3. Prices: $50.00 CAN.

In response to increasing environmental concerns associated with the handling and disposal of natural gas plant waste sludges, Enviro-Test Laboratories was commissioned by the Canadian Petroleum Association and Environment Canada to develop cost-effective analytical methods to analyze gas plant sludges and associated liquids (centrifugates) for the presence of hazardous substances. Samples of sludge and centrifugate were obtained from sour gas plants using different processes (e.g. monoethanolamine, diethanolamine and sulfinol) to sweeten the gas and were analyzed for volatile, solvent extractable, and intractable priority chemicals. Identifications of the major components of each type of waste were made. The method used involves extraction of the sample followed by chemical fractionation of the extract on alumina and analysis of the fractions by gas chromatography (GC)/Flame Ionization Detector. Those fractions showing significant GC peaks are reanalyzed by GC/mass spectroscopy to determine the major components and to search for priority chemicals associated with those fractions. Intractable or water-soluble compounds are also addressed with this method. In conclusion, it should be emphasized that the most cost effective way to dispose of a waste depends on knowledge of its content. 5 refs., 3 figs., 4 tabs.

0308 Environmental Aspects

Refer also to citation(s) 19281, 19287, 19288, 19289, 19290, 19291, 19292, 19293, 19294

0320 Transport, Handling, and Storage

Refer also to citation(s) 19690, 20070

19305 Gri program to develop performance data on in-line-inspection tools for pipeline revalidation. Eiber, R.J. (Battelle Memorial Inst., Columbus, OH (USA)); Kiefner, J.F.; Hyatt, R.W. pp. 750 of Proceedings of the eighth international conference on offshore mechanics and Arctic engineering. 1989. Chung, J.S.; Ellinas, C.P.; Natvig, B.J.; Wardenier, J.; Penny, T.R. American Society of Mechanical Engineers, New York, NY (1989). (CONF-890325–: 8. international conference on offshore mechanics and arctic engineering, The Hague (Netherlands), 19-23 Mar 1989).

Under the auspices of the American Gas Association, the gas industry was surveyed to define their usage and needs for in-line-inspection (ILI) tool capabilities. Based on the needs identified, a program to address those needs has been initiated by the Gas Research Institute. The GRI program, presented in this paper, is aimed at developing performance data on ILI tools under controlled conditions and at developing new inspection technologies for new ILI tools.

0330 Properties and Composition

19306 (PB–90-130329/XAB) **Molecular-theory and computer-simulation studies of natural and synthetic gas mixtures. Annual report, January 1-December 31, 1988.** Gubbins, K.E. Cornell Univ., Ithaca, NY (USA). School of Chemical Engineering. 31 Jan 1989. 45p. Available from NTIS, PC A03/MF A01.

See also PB–88-229984.

The effect of molecular associations on the phase equilibria of fluids with multiple bonding sites is investigated. Initially, the individual molecules are represented by hard-sphere repulsive cores with off-center, square-well attractive sites. Such a system's thermodynamic properties can be calculated by using expressions based on a theory recently proposed by Wertheim. A simple van der Waals mean-field term is also added to account for the dispersion forces. Isothermal-isobaric Monte Carlo simulations of hard-sphere fluids with one and two attractive sites are shown to be in good agreement with the results of the theory. The critical points and phase equilibria of the associating fluids are determined for various values of the strength and range of the attractive site. Furthermore, results are presented for the degree of association in

the gas and liquid phases along the vapor pressure curve. The effect of size is then incorporated by developing an equation of state for chain molecules. The theory can treat fluids with strong hydrogen-bonding associations such as the carboxylic acids, the aliphatic alcohols, hydrogen fluoride, water, etc.

04 OIL SHALES AND TAR SANDS

0402 Reserves, Geology, and Exploration

Refer also to citation(s) 19298, 19299

0404 Oil Production, Recovery, and Refining

Refer also to citation(s) 19312

19307 (CONF-881128–3) **Pressurized fluidized-bed hydroretorting of Eastern oil shales.** Roberts, M.; Lau, F.; Punwani, D. Institute of Gas Technology, Chicago, IL (USA). 1988. 19p. Sponsored by Institute of Gas Technology. From Eastern oil shale symposium; Lexington, KY (USA); 30 Nov - 2 dec 1988. Available from OSTI; Institute of Gas Technology, 3424 South State St., Chicago, IL 60616.

The Institute of Gas Technology (IGT) is conducting a 3-year research program for the development of a pressurized fluidized-bed hydroretorting (PFH) process for the production of oil from Eastern oil shales. As a part of this program, the effects of a large number of process variables on product yields are being determined in a newly constructed laboratory-scale batch test unit. The batch test unit is 2 inches in diameter and is designed to process up to 200 grams of shale sample, and operate at temperatures and pressures up to 1200°F and 1000 psig, respectively. The batch unit is designed to simulate not only the retorting zone, but also the shale preheat zone of a conceptual PFH reactor. This paper will describe the lab-scale equipment and present results of the tests conducted to date. 2 refs., 14 figs.

19308 (CONF-891167–2) **Pressurized fluidized-bed hydroretorting of Indiana New Albany shale in batch and continuous units.** Roberts, M.J. (Institute of Gas Technology, Chicago, IL (USA)); Rue, D.M.; Lau, F.S.; Roosmagi, C. Institute of Gas Technology, Chicago, IL (USA). 1989. 17p. Sponsored by Institute of Gas Technology. From Eastern oil shale symposium; Lexington, KY (USA); 15-17 Nov 1989. Available from OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616.

Work is being conducted at the Institute of Gas Technology (IGT) to develop a pressurized fluidized-bed hydroretorting (PFH) process for the production of oil from Eastern oil shales. The PFH process, using smaller particle sizes than the moving-bed hydroretorting process, offers higher oil yields and greater reactor mass fluxes through higher selectivity of organic carbon to oil and shorter residence times, respectively. Batch PFH tests have been conducted to study the effects of shale preheat time (15 to 30 min) and temperature (25° to 320°C), retorting temperature (450° to 710°C), hydrogen pressure (2.8 to 7.0 MPa), particle size (65 to 330 microns), and residence time (5 to 30 min) on the product yields from Indiana New Albany shale. Oil yield has been found to increase with increasing hydrogen pressure. Results are discussed. 10 refs., 14 figs., 3 tabs.

19309 (CONF-891167–3) **Microbial desulfurization of Eastern oil shale: Bioreactor studies.** Maka, A.; Akin, C.; Punwani, D.V.; Lau, F.S.; Srivastava, V.J. Institute of Gas Technology, Chicago, IL (USA). [1989]. 9p. Sponsored by Institute of Gas Technology. From Eastern oil shale symposium; Lexington, KY (USA); 15-17 Nov 1989. Available from OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616.

The removal of sulfur from Eastern oil shale (40 microns particle size) slurries in bioreactors by mixed microbial cultures was examined. A mixed culture that is able to remove the organic sulfur from model sulfur compounds presenting coal as well as a mixed culture isolated from oil shale enrichments were evaluated. The cultures were grown in aerobic fed-batch bioreactors where the oil shale served as the source of all nutrients except organic carbon. Glucose was added as an auxiliary carbon source. Microbial growth was monitored by plate counts, the pH was checked periodically, and oil shale samples were analyzed for sulfur content. Results show a 24% reduction in the sulfur content of the oil shale after 14 days. The settling characteristics of the oil shale in the bioreactors were examined in the presence of the microbes. Also, the mixing characteristics of the oil shale in the bioreactors were examined. 10 refs., 6 figs., 5 tabs.

19310 (DOE/MC/11076–2789) **Economic enhancement of Western shale oil upgrading.** Bunger, J.W.; Ryu, H.; Jeong, S.Y. Western Research Inst., Laramie, WY (USA); Utah Univ., Salt Lake City, UT (USA). Jul 1989. 29p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC21-86MC11076. Order Number DE90000458. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A proof-of-concept study for a novel shale oil refining process was undertaken. This project promises reduced upgrading costs, thereby making shale oil development more feasible for commercialization. The process consists of distillation of raw shale oil into a distillate and residue portion, cracking of the residue by hydropyrolysis, and selective hydrotreating of narrow boiling cuts from the total distillate. Based on models and experimental data, the end product slate is projected to be 34% naphtha, 57% middle distillate, and 10.3% atm residue + coke. Hydrogen addition is 1.3% or 800 scf/bbl. These results are considerably improved over conventional processing, which gives 14% naphtha, 41% middle distillate, and 48.2% residue + coke and hydrogen addition of 3.2% or 2000 scf/bbl. More quantitative data and preliminary economics will be obtained in the next phase of study. 13 refs., 3 figs., 6 tabs.

19311 **Water generation during pyrolysis of oil shales. 1. Sources.** Coburn, T.T. (Lawrence Livermore National Laboratory, CA (USA)); Oh, M.S.; Crawford, R.W.; Foster, K.G. *Energy and Fuels (USA)*, 3(2): 216-223 (Mar-Apr 1989).

Water formation has an impact on both the chemistry and energy balance in an oil shale retort. Quantitative measurements of real-time water releases as oil shale is heated have not been available previously. We have developed a mass spectrometric method and have applied it to the study of water evolution during batch pyrolysis of oil shale in a small thermal-gradient vessel. We have investigated a Devonian oil shale (Kentucky, New Albany Shale) and a Green River Formation oil shale (Colorado, Mahogany Zone). Precursors of pyrolysis water are different for these oil shales since they differ in mineralogy and kerogen structure. Each of the following types of water contributes to a greater or lesser extent: (a) free water; (b) water from hydrated minerals; (c) water from the reaction of iron compounds with H_2S; (d) water from elimination of organic oxygen; (e) equilibrated water. Pyrolysis of acid-leached Green River oil shale and Fischer assay water release provide additional details. We have applied our methods to an Israeli oil shale and compared the results to a previous report. An appendix with quality-assurance results is included.

0405 Properties and Composition

19312 **Rate of intermolecular association of asphalt ridge tar sand bitumen after thermal dissociation.** Netzel, D.A. (Western Research Institute, Laramie, WY (USA)); Coover, P.T. *Energy and Fuels (USA)*, 3(2): 259-262 (Mar-Apr 1989).

It is known that reversible thermal cycling implies that intermolecular interactions of the types dipole-dipole or dipole-induced dipole, rather than a chemical reaction, are responsible for the exothermic reactions in complex organic mixtures. A preliminary study was conducted to determine if the reversible intermolecular interactions of Asphalt Ridge tar sand bitumen could be followed by using nuclear magnetic resonance relaxation spectroscopy. The NMR data indicate that the intermolecular association of molecules in the bitumen to their original molecular configuration after thermal dissociation is mechanistically a pseudo-first-order process requiring nearly a week to establish an intermolecular-interaction equilibrium. The first-order rate constant was found to be 0.0139 h^{-1} at a mean temperature of 32°C.

0407 Health and Safety

19313 (HAZ–CE02855, pp. 113-126) **Implementing the WHMIS [Workplace Hazardous Materials Information System] legislation into Syncrude's loss management program.** Doyle, J.R. Haztech Canada, Edmonton, AB (Canada). 1988. (CONF-8810478–: Haztech western Canada: hazardous waste management and environmental control conference, Edmonton (Canada), 5-6 Oct 1988; CE–02855). In *Haztech Western Canada '88: Hazardous waste management and environmental control conference proceedings.* Available from Haztech Canada, 4936-87th St., no. 26, Edmonton, AB, CAN T6E 5W3. Prices: $50.00 CAN.

The Syncrude operation is very large and complex, consisting of an open-pit mine, a bitumen extraction plant, an upgrading plant, and a 22 km^2 tailings pond. Central to this operation is a commitment to loss management as the means to realize a safe and reliable operation. The loss management program is a systematic approach to the elimination of incidents and to the reduction of the risks to people, production, equipment, and the environment. It is in this context that the CMIS (Chemical Management in Syncrude) project was developed and that compliance with WHMIS (Workplace Hazardous Materials Information System) regulations was achieved. This paper reviews the elements of the CMIS program that directly relate to compliance with the WHMIS legislation; it also discusses the integration of CMIS with other loss management programs throughout the company. Chemical inventory, including MSDS (Material Safety Data Sheets), chemical approval, MSDS manuals, and labelling (including colour codes) are presented. Employee training and compliance audits are discussed. In conclusion, the benefits of the regulations can be greater than the identification of chemical hazards and the protection of the workers from such hazards. Moreover, the scope of the program should not be limited to WHMIS controlled products alone. 3 figs., 1 tab.

0409 Waste Management

Refer also to citation(s) 19282, 19722, 19723

0410 Environmental Aspects

Refer also to citation(s) 20357

05 NUCLEAR FUELS

0504 Feed Processing

19314 (IAEA-TECDOC–533) **The recovery of uranium from phosphoric acid: Report of an advisory group meeting held in Vienna, 16-19 March 1987.** International Atomic Energy Agency, Vienna (Austria). Nov 1989. 104p. (CONF-8703332–: Advisory group meeting on the recovery of uranium from phosphoric acid, Vienna (Austria), 16-19 Mar 1987). Order Number DE90617372. Available from NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS.

Phosphoric acid is an important alternative source of uranium: the world's reserves of phosphoric rock are estimated to be about 18,000 million tonnes and there are approximately 400 wet-process phosphoric acid plants in operation from which some 13,000 metric tonnes of U_3O_8 could in principle be recovered each year. The recovery of uranium from wet-process phosphoric acid is a proven technology that is being used commercially, albeit on a limited scale because currently prevailing market conditions make it marginally economic. Nevertheless, many developing countries are interested in the recovery of uranium from phosphoric acid for use in their own nuclear power programmes. Several important reasons, such as assurance of supply, savings in foreign currency, acquisition of technology and generation of employment, may render this operation attractive in spite of the marginal economics. In view of the interest shown by several Member States, the International Atomic Energy Agency convened an Advisory Group Meeting on the Recovery of Uranium from Phosphoric Acid from 16 to 19 March 1987 with the main objectives of reviewing the current status of the technology and to suggest guidelines for the application of existing processes in developing countries. This document includes a Summary and Recommendations, followed by two review papers which discuss the current status of the technology and industrial practice of uranium recovery from phosphoric acid. Other papers discuss operating experience and current research and development work. Two Panel Discussions are also included, one on capital and operating costs and the other on guidelines for the preparation of feasibility studies. Refs, Figs and tabs.

19315 (IAEA-TECDOC–533, pp. 9-15) **Recovery of uranium from phosphates: Current status and trends.** Hurst, F.J. International Atomic Energy Agency, Vienna (Austria). Nov 1989. (CONF-8703332–: Advisory group meeting on the recovery of uranium from phosphoric acid, Vienna (Austria), 16-19 Mar 1987). In *The recovery of uranium from phosphoric acid: Report of an advisory group meeting held in Vienna, 16-19 March 1987.* Order Number DE90617372. Available from NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS.

Commercialization of three processes (OPPA, DEPA-TOPO and OPAP) has shown that the DEPA-TOPO process offers the best technology available today for the recovery of uranium from wet process phosphoric acid. Uranium recovery plants using this process have been successfully operated in the United States, Belgium, Canada and Taiwan. Operating experience from these plants has led to a significant reduction in both capital and operating costs making the DEPA-TOPO process more attractive in today's depressed uranium market. The main process improvements developed at the Oak Ridge National Laboratories are summarized and current process economics are reviewed. New processes now being studied are discussed, including processes using new extractants, ion-exchange resins and liquid membranes and processes for the recovery of uranium from the semi-hydrate phosphoric acid process. (author). 12 refs, 1 tab.

19316 (IAEA-TECDOC–533, pp. 17-35) **Recovery of uranium from phosphoric acid: An overview. .** Botella, T. (Centro de Investigaciones Energeticas Medioambientales y Tecnologicas (CIEMAT), Madrid (Spain). Programa de Procesos Mineralurgicos); Gasos, P. International Atomic Energy Agency, Vienna (Austria). Nov 1989. (CONF-8703332–: Advisory group meeting on the recovery of uranium from phosphoric acid, Vienna (Austria), 16-19 Mar 1987). In *The recovery of uranium from phosphoric acid: Report of an advisory group meeting held in Vienna, 16-19 March 1987.* Order Number DE90617372. Available from NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS.

Wet-process phosphoric acid is one of the most important potential sources of uranium. In spite of the current low market price of uranium, there are many reasons which can make the recovery of this material from phosphoric acid attractive, specially in countries without conventional uranium ore bodies. Several processes, types of equipment and reagents have been studied in order to improve the economics of uranium recovery therefore making this alternative resource more attractive in comparison to conventional ores. (author). 34 refs.

19317 (IAEA-TECDOC–533, pp. 37-44) **Improvements and results acquired through six years of industrial uranium extraction from phosphoric acid by the Prayon process.** Davister, A. (Prayon Developpement SA, Engis (Belgium)); Martin, J. International Atomic Energy Agency, Vienna (Austria). Nov 1989. (CONF-8703332–: Advisory group meeting on the recovery of uranium from phosphoric acid, Vienna (Austria), 16-19 Mar 1987). In *The recovery of uranium from phosphoric acid: Report of an advisory group meeting held in Vienna, 16-19 March 1987.* Order Number DE90617372. Available from NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS.

UMIPRAY, S.A. has been recovering uranium from phosphoric acid since 1980 using the DEHPA/TOPO process. The main characteristics of the process are described and recent process innovations are discussed. These include the use of low-level flash coolers for acid cooling during pretreatment, improved control of the first-cycle reductive stripping, improved post-treatment of the first-cycle raffinate using a lamella settler and air-induced flotation, the use of gaseous oxygen instead of hydrogen peroxide for second-cycle acid oxidation, improved filtering and dewatering of

the uranium concentrate and progressive introduction of automatic control for plant operation. (author). 6 refs, tabs.

19318 (IAEA-TECDOC–533, pp. 45-57) **The D/T extraction process and its application to a phosphoric acid.** Schneider, B. (Uraphos Chemie GmbH, Berlin (Germany, F.R.)). International Atomic Energy Agency, Vienna (Austria). Nov 1989. (CONF-8703332–: Advisory group meeting on the recovery of uranium from phosphoric acid, Vienna (Austria), 16-19 Mar 1987). In *The recovery of uranium from phosphoric acid: Report of an advisory group meeting held in Vienna, 16-19 March 1987.* Order Number DE90617372. Available from NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS.

The DEHPA/TOPO process used by the Uraphos Chemie plant in Florida and the Uraphos amine/polyphosphate (A/P) uranium extraction process are described. The industrial plant in Florida uses a conventional DEHPA/TOPO process with acid preconditioning, first cycle extraction in six mixer-settlers, raffinate post treatment, second-cycle extraction in four stages, stripping and precipitation. The Uraphos A/P process uses a tertiary amine (2% trilaurylamine) as extractant and a long-chain polyphosphate as complexing agent for tetravalent uranium. The process includes acid pretreatment, first-cycle extraction and stripping, precipitation of $Na_2U_2O_7$ as an intermediate product, dissolution of the intermediate product, second-stage extraction and stripping and precipitation of sodium diuranate as a final product. A mobile pilot plant with a capacity of 200 L of phosphoric acid per hour has been built to demonstrate the process. A test programme to study the suitability of the DEHPA/TOPO process or the A/P process for the treatment of a given phosphoric acid is outlined. (author). 6 figs.

19319 (IAEA-TECDOC–533, pp. 59-68) **Recovery of uranium from phosphoric acid by ion exchange.** Volkman, Y. (Israel Atomic Energy Commission, Beersheba (Israel). Nuclear Research Center-Negev). International Atomic Energy Agency, Vienna (Austria). Nov 1989. (CONF-8703332–: Advisory group meeting on the recovery of uranium from phosphoric acid, Vienna (Austria), 16-19 Mar 1987). In *The recovery of uranium from phosphoric acid: Report of an advisory group meeting held in Vienna, 16-19 March 1987.* Order Number DE90617372. Available from NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS.

The ion-exchange process developed by the Nuclear Research Center at Negev and the pilot plant built to demonstrate it are described. The process includes acid pre-treatment, absorption on Duolite ES-467 ion-exchange resin, elution and precipitation. A pilot plant with a capacity of 100 L/hr of fresh phosphoric acid was built adjacent to the Rotem phosphoric acid plant (Negev) and operated intermittently from 1984 to mid-1986. Overall uranium recovery was about 90% and the concentrate produced met commercial specifications. An economic analysis of the process is also given. (author). 1 ref., 3 figs, 1 tab.

19320 (IAEA-TECDOC–533, pp. 87-91) **Summary of the work on the Phosphate Research Centre (CERPHOS) in uranium extraction from phosphoric acid.** Ezahr, I. (CERPHOS/Groupe OCP, Casablanca (Morocco)). International Atomic Energy Agency, Vienna (Austria). Nov 1989. (CONF-8703332–: Advisory group meeting on the recovery of uranium from phosphoric acid, Vienna (Austria), 16-19 Mar 1987). In *The recovery of uranium from phosphoric acid: Report of an advisory group meeting held in Vienna, 16-19 March 1987.* Order Number DE90617372. Available from NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS.

The Sherifian Phosphate Office (OCP) established its own research centre (CERPHOS) in 1975 to carry out the necessary work for its expansion plans. The capabilities of CERPHOS and the results obtained in the areas of ore characterization, ore processing, chemical upgrading of phosphates, corrosion and resistance of materials and project engineering are described. (author).

0507 Fuels Production and Properties

Refer also to citation(s) 20310, 20311, 20312, 20313, 20314, 20315, 20316, 20317, 20318, 20319, 20320, 20321, 20322

0508 Spent Fuels Reprocessing

Refer also to citation(s) 19362, 19444

19321 (IAEA-TECDOC–533, pp. 69-85) **Laboratory and pilot plant studies for the recovery of uranium from phosphoric acid by the D2EHPA-TOPO process.** Botella, T. (Centro de Investigaciones Energeticas Medioambientales y Tecnologicas (CIEMAT), Madrid (Spain). Programa de Procesos Mineralurgicos); Gasos, P. International Atomic Energy Agency, Vienna (Austria). Nov 1989. (CONF-8703332–: Advisory group meeting on the recovery of uranium from phosphoric acid, Vienna (Austria), 16-19 Mar 1987). In *The recovery of uranium from phosphoric acid: Report of an advisory group meeting held in Vienna, 16-19 March 1987.* Order Number DE90617372. Available from NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS.

The activities and costs involved in laboratory and pilot plant studies are discussed as applied to the D2EHPA-TOPO process. The overall capital investment (including engineering) for a plant with a throughput of 12 cubic meters of acid/day has been estimated to be around one million US dollars. Operating costs per year, without considering amortization and labor, are over 20,000 US dollars. A total time of 3,5 years (including engineering, purchase and pilot plant tests) could be needed to obtain the information required for final scale-up. (author). 40 refs, 1 fig., 5 tabs.

19322 (WHC-SA–0533) **Evaluation of adsorbents for removal of plutonium from a low-level process wastewater.** Barney, G.S.; Blackman, A.E.; Lueck, K.J.; Green, J.W. Westinghouse Hanford Co., Richland, WA (USA). Feb 1989. 13p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. (CONF-8905122–8: 13. actinide separations conference, Idaho Falls, ID (USA), May 1989). Order Number DE90007028. Available from NTIS, PC A03/MF A01; OSTI; INIS.

Plutonium removal from a low-level wastewater effluent of the Plutonium Finishing Plant at the Hanford Site was tested using ten different commercially available adsorbents. The objective of this work was to select an adsorbent to be used in a new wastewater treatment facility at the plant. Batch plutonium distribution coefficients (Kd) were measured for each adsorbent as well as plutonium breakthrough curves for laboratory columns. Plutonium adsorption was studied over the range of pH values expected for the wastewater (5 to 9) and at several plutonium concentrations (2.5×10^{-10} M and 2.5×10^{-9} M). The rate of plutonium adsorption was studied by varying the flow rate of Pu-238-spiked wastewater passing through the columns. The ten adsorbents studied included cation and anion exchange resins, activated alumina, bone char, and metal removal agents. In the batch equilibrium measurements, plutonium was most strongly adsorbed on the bone char and on the metal removal agents. Distribution coefficients for bone char and Bioclaim-MRA ranged from 8300 to 31,000 ml/g and from 2400 to 6700 ml/g, respectively. Plutonium adsorption on the anion resins and the activated alumina was strongly dependent on pH (adsorption increased at high pH). Plutonium adsorption on the bone char adsorbent was the most rapid and gave the highest decontamination factors (approximately 400 to 3000, depending on flow rate) for the column experiments. 11 refs., 8 figs., 4 tabs.

0509 Transport, Handling, and Storage

Refer also to citation(s) 19368, 19443, 20052, 20053, 20054, 20055, 20056, 20057, 20058, 20059, 20060, 20061, 20062, 20079, 20080, 20082

19323 (ANL/EAIS/TM–2) **Data base of accident and agricultural statistics for transportation risk assessment.** Saricks, C.L.; Williams, R.G.; Hopf, M.R. Argonne National Lab., IL (USA). Nov 1989. 59p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-31109-ENG-38. Order Number DE90006468. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

A state-level data base of accident and agricultural statistics has been developed to support risk assessment for transportation of spent nuclear fuels and high-level radioactive wastes. This data base will enhance the modeling capabilities for more route-specific analyses of potential risks associated with transportation of these

wastes to a disposal site. The data base and methodology used to develop state-specific accident and agricultural data bases are described, and summaries of accident and agricultural statistics are provided. 27 refs., 9 tabs.

19324 (CONF-900406–32) **Operational considerations in specifying legal weight vehicles for the highway transport of spent nuclear fuel.** Hill, C.V. (Science Applications International Corp., Oak Ridge, TN (USA)); Rutenkroger, E.O.; Ratledge, J.E. Oak Ridge National Lab., TN (USA). [1990]. 9p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC05-84OR21400. From International conference for high-level radioactive waste management; Las Vegas, NV (USA); 8-12 Apr 1990. Order Number DE90007055. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This paper presents the results of a research project in which tractor manufacturers and carrier companies were interviewed to gather information on operational concerns in specifying a tractor to haul legal weight spent fuel casks. The system was assumed to operate very close to the 80,000 pound legal weight limit. Safety, performance, reliability, and maintainability of equipment were factors given particular attention. The interaction between driver fatigue, safety, and equipment was also discussed. Innovative operating strategies that could save weight were discussed. The paper concluded that operational considerations require that planners working with standard off-the-shelf tractor equipment should allow at least 17,350 pounds for the weight of the tractor as a starting point from which further weight reduction analysis can proceed. 4 refs., 3 figs.

19325 (SAND–89-3046C) **Development of a "CRUD" particle size distribution and its effect on cask source term and containment analyses.** Thornhill, C.K. (Pacific Northwest Lab., Richland, WA (USA)); Jordan, H.; Sanders, T.; Lake, W.H. Sandia National Labs., Albuquerque, NM (USA). [1989]. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900406–20: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90006043. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Spent pressurized-water reactor (PWR) and boiling-water reactor (BWR) fuel rods from three reactors were examined by hot cell periscope, energy dispersive x-ray analysis, and scanning electron micrography. In the case of fuel from the Quad Cities reactor, it was possible to develop a complete particle size distribution. It was found to be log-normal, with a median geometric diameter of 3 μm and a standard deviation of 1.87 μm. 5 refs., 5 figs., 1 tab.

19326 (WHC-SA–0749) **US DOE-HQ Transportation Management Division Motor Carrier Evaluation Program.** Portsmouth, J.H. Westinghouse Hanford Co., Richland, WA (USA). Jan 1990. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. (CONF-900406–23: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90006311. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Key elements in the Department of Energy's effective hazardous and radioactive materials shipping program are (1) integrity of packages, (2) strict adherence to regulations and procedures, (3) trained personnel, (4) complete management support, and (5) use of the best commercial carriers. The DOE Motor Carrier Evaluation Program was developed to better define the criteria and methodology needed to identify motor carriers for use in the transportation of Highway Route Controlled Quantities (HRCQ) and Truck Load (TL) quantities of radioactive materials.

0510 Economic, Industrial, and Business Aspects

Refer also to citation(s) 19314, 19317, 19318, 19319, 19321, 19701

0520 Waste Management

Refer also to citation(s) 19257, 19324, 19326, 19421, 19424, 19439, 19440, 19441, 19443, 19444, 19791, 19792, 19808, 19886, 19935, 19993, 20046, 20063, 20069, 20074, 20078, 20080, 20081, 20084, 20210, 20345, 20358, 20360, 20369, 20370, 20375, 20380, 20381, 20401, 20788

19327 (AECL–9685) **The physical and chemical environment and radionuclide migration in a low level radioactive waste repository.** Torok, J.; Buckley, L.P. Atomic Energy of Canada Ltd., Chalk River, ON (Canada). Chalk River Nuclear Labs. Jan 1988. 15p. (CONF-8711200–: NEA workshop on near-field assessment of repositories for low and medium level radioactive waste, Baden (Switzerland), 23-26 Nov 1987). Order Number DE90617944. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The expected physical and chemical environment within the low-level radioactive waste repository to be sited at Chalk River is being studied to establish the rate of radionuclide migration. Chemical conditions in the repository are being assessed for their effect on buffer performance and the degradiation of the concrete structure. Experimental programs include the effect of changes in solution chemistry on radionuclide distribution between buffer/backfill materials and the aqueous phase; the chemical stability of the buffer materials and the determination of the controlling mechanism for radionuclide transport during infiltration.

19328 (BNL–43768) **^{14}C release from failed spent fuel containers.** Pescatore, C. Brookhaven National Lab., Upton, NY (USA). [1990]. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-900406–29: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90007833. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Partially failed containers may provide a meaningful barrier to the release of gaseous radionuclides. A modeling approach is outlined and sample calculations are provided that show the effects on release due to a limited perforation area, to decreasing temperature, and to the partial occlusion of the perforated area by corrosion products. 8 refs., 2 tabs.

19329 (CEA-DAS–614) **Evaluation of the radiological consequences of a human intrusion in a granite formation.** Mejon-Goula, M.J.; Cernes, A. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. d'Analyse de Surete. Jul 1989. 12p. (In French). (CONF-8906288–: OECD seminar on intrusion, Paris (France), 5-7 Jun 1989). Order Number DE90752544. Available from NTIS (US Sales Only), PC A03/MF A01.

The methodology used in France for the evaluation of the radiological consequences associated to a nuclear waste repository in a deep geological formation is the deterministic one. This means that, in addition to the calculations in connection with the "normal" scenario, a limited number of "altered" scenarios, representing the different families of plausible scenarios and corresponding to the most important consequences resulting from there families, have to be taken into account. Among them, the human intrusion scenario is an important one. In a study performed inside the CEC PAGIS project and also for a french expert group (Goguel group) which carried out a methodologic work for the national site selection procedure, results concerning the quantification of the radiological consequences of a human intrusion have been obtained without attempting at the evaluation of its probability. The intrusion time ranged from 1 000 to 100 000 years and different contamination scenarios were taken into account. It was assumed that the intrusion led to the creation of a 100 cubic meters edge cubic cavity in the immediate vicinity to the repository. Using the description of the Auriat site realized for PAGIS, the calculation was performed in three steps: - calculation of the evolution of the repository until the intrusion time, - computation of the supposed instantaneous new flow distribution after the intrusion, - computation of the dose rate, using the mean volumic activity in the cavity walls and the outgoing flow rate. Three exposure scenarios were considered: - a worker in the mine exposed to by external irradiation and contaminated by inhalation of radioactive materials, -an animal drinking in the vicinity during the mining operation, - gardening after the closure of the mine.

19330 (CONF-900210–11) **Department of Energy Waste Information Network: Hazardous and mixed waste data management.** Fore, C.S. Oak Ridge Gaseous Diffusion Plant, TN

(USA). [1990]. 6p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OT21400. From 16. annual waste management symposium: working towards a cleaner environment; Tucson, AZ (USA); 25 Feb - 1 mar 1990. Order Number DE90007124. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The Department of Energy (DOE) Waste Information Network (WIN) was developed through the efforts of the DOE Hazardous Waste Remedial Actions Program (HAZWRAP) Support Office (SO) to meet the programmatic information needs of the Director, Office of Environmental Restoration and Waste Management. WIN's key objective is to provide DOE Headquarters (HQ), DOE Operations Offices, and their contractors with an information management tool to support environmental restoration and waste management activities and to promote technology transfer across the DOE complex. WIN has evolved in various stages of growth driven by continued identification of user needs. The current system provides seven key features: technical information systems, bulletin boards, data file transfer, on-line conferencing, formal concurrence system, electronic messaging, and integrated spreadsheet/graphics. WIN is based on Digital Equipment Corporation;s (DEC) VAXcluster platform and is currently supporting nearly 1,000 users. An interactive menu system, DEC's ALL-IN-1 (1), provides easy access to all applications. WIN's many features are designed to provide the DOE waste management community with a repository of information management tools that are accessible, functional, and efficient. The type of tool required depends on the task to be performed, and WIN is equipped to serve many different needs. Each component of the system is evaluated for effectiveness for a particular purpose, ease of use, and quality of operation. The system is fully supported by project managers, systems analysts, and user assistance technicians to ensure subscribers of continued, uninterrupted service. 1 ref.

19331 (CONF-900210–12) **Proposed success demonstration criteria for the Department of Energy's waste reduction efforts.** Suffern, J.S. Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA). [1990]. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-84OR21400. From 16. annual waste management symposium: working towards a cleaner environment; Tucson, AZ (USA); 25 Feb - 1 mar 1990. Order Number DE90007106. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Seven proposed criteria for demonstration of success in waste reduction have been developed: reduced amount of hazardous waste, reduced waste management cost, improved regulatory compliance, reduced health risk, increased production efficiency, reduced accident risk, and improved public relations. A detailed description of each of the criteria is presented along with a discussion for each of the mechanisms for measurement, required commitments, strengths, and weaknesses. 2 refs.

19332 (CONF-900279–1) **Transportation safety training.** Jones, E. Oak Ridge National Lab., TN (USA). [1990]. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From DOE health and safety conference; Washington, DC (USA); 28 Feb 1990. Order Number DE90007057. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Over the past 25 years extensive federal legislation involving the handling and transport of hazardous materials/waste has been passed that has resulted in numerous overlapping regulations administered and enforced by different federal agencies. The handling and transport of hazardous materials/waste involves a significant number of workers who are subject to a varying degree of risk should an accident occur during handling or transport. Effective transportation training can help workers address these risks and mitigate them, and at the same time enable ORNL to comply with the federal regulations concerning the transport of hazardous materials/waste. This presentation will outline how the Environmental and Health Protection Division's Technical Resources and Training Section at the Oak Ridge National Laboratory, working with transportation and waste disposal personnel, have developed and implemented a comprehensive transportation safety training program to meet the needs of our workers while satisfying appropriate federal regulations. 8 refs., 3 tabs.

19333 (CONF-900403–3) **Stress corrosion cracking of candidate materials for nuclear waste containers.** Maiya, P.S.; Shack, W.J.; Kassner, T.F. Argonne National Lab., IL (USA). Sep 1989. 37p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-31109-ENG-38. From Corrosion '90; Las Vegas, NV (USA); 23-27 Apr 1990. Order Number DE90003827. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Types 304L and 316L stainless steel (SS), Incoloy 825, Cu, Cu-30%Ni, and Cu-7%Al have been selected as candidate materials for the containment of high-level nuclear waste at the proposed Yucca Mountain Site in Nevada. The susceptibility of these materials to stress corrosion cracking has been investigated by slow-strain-rate tests (SSRTs) in water which simulates that from well J-13 (J-13 water) and is representative of the groundwater present at the Yucca Mountain site. The SSRTs were performed on specimens exposed to simulated J-13 water at 93°C and at a strain rate 10^{-7} s^{-1} under crevice conditions and at a strain rate of 10^{-6} s^{-1} under both crevice and noncrevice conditions. All the tests were interrupted after nominal elongation strains of 1–4%. Examination by scanning electron microscopy showed some crack initiation in virtually all specimens. Optical microscopy of metallographically prepared transverse sections of Type 304L SS suggests that the crack depths are small (<10 μm). Preliminary results suggest that a lower strain rate increases the severity of cracking of Types 304L and 316L SS, Incoloy 825, and Cu but has virtually no effect on Cu-30%Ni and Cu-7%Al. Differences in susceptibility to cracking were evaluated in terms of a stress ratio, which is defined as the ratio of the increase in stress after local yielding in the environment to the corresponding stress increase in an identical test in air, both computed at the same strain. On the basis of this stress ratio, the ranking of materials in order of increasing resistance to cracking is: Types 304L SS < 316L SS < Incoloy 825 ≅ Cu-30%Ni < Cu ≅ Cu-7%Al. 9 refs., 12 figs., 7 tabs.

19334 (CONF-900406–11) **Characteristics of potential repository wastes.** Notz, K.J. Oak Ridge National Lab., TN (USA). [1989]. 21p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC05-84OR21400. From International conference for high-level radioactive waste management; Las Vegas, NV (USA); 8-12 Apr 1990. Order Number DE90005455. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Office of Civilian Radioactive Waste Management (OCRWM) is responsible for the spent fuels and other wastes that will be disposed of in a geologic repository. The two major sources of these materials are commercial light-water reactor (LWR) spent fuel and immobilized high-level waste (HLW). Other wastes that may require long-term isolation include non-LWR spent fuels and miscellaneous sources such as activated metals. Detailed characterizations are required for all of these potential repository wastes. These characterizations include physical, chemical, and radiological properties. The latter must take into account decay as a function of time. This information has been extracted from primary data sources, evaluated, and assembled in a Characteristics Data Base which provides data in four formats: hard copy standard reports, menu-driven personal computer (PC) data bases, program-level PC data bases, and mainframe computer files. The Characteristics Data Base provides a standard set of self-consistent data to the various areas of responsibility including systems integration and waste stream analysis, storage, transportation, and geologic disposal. The data will be used for design studies, evaluation of alternatives, and system optimization by OCRWM and supporting contractors. 7 refs., 5 figs., 7 tabs.

19335 (CONF-900406–33) **Two citizen task forces and the challenge of the evolving nuclear waste siting process.** Peelle, E.B. Oak Ridge National Lab., TN (USA). [1990]. 12p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC05-84OR21400. From International conference for high-level radioactive waste management; Las Vegas, NV (USA); 8-12 Apr 1990. Order Number DE90006145. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Siting any nuclear waste facility is problematic in today's climate of distrust toward nuclear agencies and fear of nuclear waste. This study compares and contrasts the siting and public participation

processes as two citizen task forces dealt with their difficult responsibilities. 10 refs., 3 tabs.

19336 (DOE/AL/10752–40) **Review of the final safety analysis report (Draft), DOE Waste Isolation Pilot Plant, December 1988.** Environmental Evaluation Group, Albuquerque, NM (USA). May 1989. 164p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-89AL58309;AC04-78AL10752. (EEG–40). Order Number DE90007377. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

These are the Environmental Evaluation Group's comments on the December 1988 Draft of the DOE Final Safety Analysis Report (FSAR) on WIPP which was received on February 13, 1989. Previously we commented on the earlier Draft FSAR, the initial 1980 Safety Analysis Report (SAR), and all nine subsequent amendments to the SAR. EEG's comments on the SAR and its amendments are summarized elsewhere. EEG's October 1988 comments were extensive and indicated there was much we believed needed to be corrected, amplified, and included in the FSAR. The current comments are equally extensive and we believe a significant amount of work still needs to be done by DOE to produce an acceptable FSAR. Many comments are repeated from our October 1988 review because the December 1988 Draft either failed to respond to all of our comments, or responded inadequately. Additional comments on the current draft involve the hazardous wastes analyses in Chapter 6 and 7 which are in the Draft FSAR for the first time. A few of the comments address issues not covered in our October 1988 review but which may have been raised previously in EEG's comments on the various SAR amendments or in other WIPP Project Office (WPO) Reports. 41 refs.

19337 (DOE/DP–0061) **Defense High-Level Waste: Quality assurance program descriptions.** USDOE Assistant Secretary for Defense Programs, Washington, DC (USA). Office of Defense Waste and Transportation Management. Oct 1988. 341p. Sponsored by U.S. DOE Defense Programs. (DOE/DP–0062;DOE/DP–0063). Order Number DE90007192. Available from NTIS, PC A15/MF A01 - OSTI.

This document describes the US Department of Energy (DOE) Office of Defense Waste and Transportation Management (DWTM) Quality Assurance Program for Defense High-Level Waste Processing. This program is being implemented to ensure the acceptability of high-level radioactive canistered waste forms for disposal in a licensed Federal Repository. The unprocessed waste has resulted from national defense programs and is presently being stored in DOE facilities at Savannah River, Hanford, and Idaho. Defense high-level waste at each DOE site will ultimately be processed into a canistered waste form suitable for repository disposal. The production of this waste at each DOE site into acceptable canistered waste forms is the responsibility of DOE. A waste form producer organization will be established at each of the sites currently storing defense waste. Each of these organizations is a composite of DOE organizations and their contractors. The composite waste form producer organization will normally consist of the following major participants: DOE Headquarters; DOE Operations Office; DOE Projects Office (if separate from an operations office); and Operating Contractors. 7 refs.

19338 (DOE/FTR–90007398) **[The Five year plan for environmental restoration]: Foreign trip report, January 19, 1990–February 3, 1990.** Oversby, V.M. Lawrence Livermore National Lab., CA (USA). 17 Feb 1990. 17p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90007398. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report describes travel undertaken by Dr. Virginia M. Oversby, Associate Division Leader for Analytical Chemistry, Lawrence Livermore National Laboratory [(415) 423-2228] with Dr. S.P. (John) Mathur of the DOE Office of Environmental Restoration and Waste Management between January 19, 1990 and February 3, 1990. The trip report date is February 17, 1990. The purpose of travel was to explain the new Five Year Plan for Environmental Restoration, the Research, Development, Demonstration, Testing, and Evaluating Plan, and the organization of the new DOE Office of Environmental Restoration and Waste Management to the installations visited and to evaluate the potential benefits to DOE from information exchange and cooperative agreements with those installations. The information gained from this trip will be used to make recommendations concerning the scope of cooperative agreements for waste management activities between DOE and the countries and installations visited.

19339 (DOE/ID–10086(88)) **US Department of Energy National Solid Waste Information Management System (NSWIMS) annual report for calendar year 1988.** Watanabe, T. EG and G Idaho, Inc., Idaho Falls, ID (USA). Sep 1989. 69p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (MISC–89118). Order Number DE90007405. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This report is generated annually from the National Solid Waste Information Management System (SWIMS) database. The SWIMS database operates under NOMAD2, fourth generation database management system. The database resides on an IBM 3083 mainframe with a virtual machine operating system. This system was implemented to meet the requirements of Energy Research and Development Administration Manual. The SWIMS database has kept pace with requirements of subsequent directives and complies with current Department of Energy (DOE) orders for retention of data on the management of solid low-level radioactive waste (LLW). SWIMS provides a comprehensive method for collecting and maintaining data related to management of US DOE and Department of Defense (DOE/Defense) related LLW. 33 figs., 29 tabs.

19340 (DOE/LLW–78T) **Long-term structural and radiological performance assessment for an enhanced abovegrade earth-mounded concrete vault.** Shuman, R. (Rogers and Associates Engineering Corp., Salt Lake City, UT (USA)); Chau, N.; Jennrich, E.A. EG and G Idaho, Inc., Idaho Falls, ID (USA); Rogers and Associates Engineering Corp., Salt Lake City, UT (USA). Dec 1989. 103p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (MISC–90003). Order Number DE90006965. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

This report presents an analysis of the long-term structural and radiological performance of a hypothetical abovegrade earth-mounded concrete vault used for the disposal of low-level radioactive waste. The vault structure design is based on the application of accepted standard engineering codes. The degradation of the concrete vault and the grouted waste forms over time and the resultant changes in the leaching and migration of radionuclides through the environment are modeled using a combination of the HELP, BARRIER, PATHRAE, and PRESTO-CPG computer codes. The resultant radiological doses to a farmer living adjacent to the facility and to several types of inadvertent intruders are calculated. These calculations show the performance of this total-system treatment and disposal concept to greatly exceed the Department of Energy's performance objectives for the protection of the general public and inadvertent intruders. 12 refs., 9 figs., 3 tabs.

19341 (DOE/NE/44139–59) **West Valley Demonstration Project community relations plan FY 1990/91.** Damerow, M.W. West Valley Nuclear Services Co., Inc., West Valley, NY (USA). Sep 1989. 10p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-81NE44139. Order Number DE90007226. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The purpose of the Community Relations Plan is to fully inform the community about the West Valley Demonstration Project (WVDP) and provide opportunities for public input. A sound approach to community relations is essential to the creation and maintenance of public awareness and community support. The WVDP is a matter of considerable public interest because it deals with nuclear waste. The mission of the WVDP is to solve an existing environmental concern by solidifying high-level radioactive waste and transporting the solidified waste to a federal repository for permanent disposal. The public requires evidence of the continued commitment and demonstrated progress of the industry and government in carrying out the mission in order to sustain confidence that the WVDP is being managed well and will be discussed successfully completed. For this reason, a comprehensive communication plan is essential for the successful completion of the WVDP.

19342 (DOE/OR/21864–3) **St. Charles County well field monitoring project: Quarterly report, October–December 1989.** Remington, S.M. Saint Charles County Water Dept., St. Charles, MO (USA). 1989. 31p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract FG05-89OR21864. Order Number DE90007180. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Results of water well sampling are discussed for the months of October, November, and December, 1989. No detections were noted in any of the analyses except the usual gross alpha and total uranium found in RMN-2. No nitroaromatics were detected. (CBS)

19343 (DOE/RL–89-16-Draft-A) **Draft single-shell tanks system closure/corrective action work plan.** USDOE Richland Operations Office, WA (USA); Westinghouse Hanford Co., Richland, WA (USA). Sep 1989. 371p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. Order Number DE90006345. Available from NTIS, PC A16/MF A01 - OSTI; GPO Dep.

This report presents an overview of the tasks and plans associated with the final disposal of single-shell tank waste operable units. The activities for reaching a disposal decision, their interrelationships, and major decision points are discussed. The strategy logistics are based on the applicable environmental regulations identified in the Hanford Federal Facility Agreement and Consent Order and adequate funding for technology development. 113 refs., 99 figs., 26 tabs.

19344 (DOE/RL–90-9) **Hanford Waste Vitrification Plant foreign alternatives feasibility study.** USDOE Richland Operations Office, WA (USA). Div. of Environmental Restoration and Waste Management. Jan 1990. 55p. Sponsored by U.S. DOE Defense Programs. Order Number DE90006473. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This report compares the Hanford Waste Vitrification Plant technology and plant design to the French AVH vitrification technology and plant design. The purpose of the report is to determine whether there would be significant advantages to redirecting the Hanford Waste Vitrification Plant Project to use the French technology and design concepts. This report was prepared in response to a Congressional request directing the Department of Energy to "conduct a feasibility study to verify existing cost estimates of the current Hanford project design and technology with alternative technology. 7 figs., 3 tabs.

19345 (DOE-RW–88.077) **The radionuclide content of radioactive wastes.** Department of the Environment, London (UK); Electrowatt Engineering Services Ltd., London (UK). Jun 1988. vp.Contract PECD-7/9/410. (UKN–60). Available from Radioactive Waste (Professional) Division. H.M. Inspectorate of Pollution. Department of the Environment. 2 Marshon Stre et. London SWIP 3EB. Available from Radioactive Waste (Professional) Division. H.M. Inspectorate of Pollution. Department of the Environment. 2 Marshon Stre et. London SWIP 3EB.

This report presents the radionuclide content of stocks and arisings of radioactive wastes in the United Kingdom. Operational and decommissioning wastes are considered for both committed and prospective plant. Arisings are from power reactors, commercial reprocessing, fuel manufacture, medical and industrial sources and research and development. Data is included from Amersham International, British Nuclear Fuels, Central Electricity Generating Board, South of Scotland Electricity Board, United Kingdom Atomic Energy Authority and minor waste producers. (author).

19346 (DOE-RW–89.058) **Immobilisation of radwaste in cement based matrices.** Glasser, F.P. (Aberdeen Univ. (UK)); Macphee, D.; Atkins, M.; Pointer, C.; Cowie, J.; Wilding, C.R.; Mattingley, N.J.; Evans, P.A. Department of the Environment, London (UK). 1989. 112p. Contract PECD-7/9/349. Order Number DE90617938. Available from NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS.

The solubilities and influence on cement pH are reported for calcium aluminate and aluminosulphate hydrates. The solubility of $Ca(OH)_2$ is reported to 700 bars. Polymerization of C-S-H is investigated by NMR. Specific interactions of U^{6+} and iodine (I^-, IO_3^-) with cement components are described. The impact of radiation on cements and the influence of higher temperature are documented. The role of dissolved Ca and CO_2 in groundwaters as dissolution media for cements are reported. (author).

19347 (DPST–82-389) **Vitrification of incinerator ASH-I dissolution rate.** Rankin, W.N. Westinghouse Savannah River Co., Aiken, SC (USA). 26 Mar 1982. 4p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90007120. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Chemical Technology Division at the Savannah River Laboratory is investigating vitrification of alpha waste incinerator (AWI) ash. In laboratory tests, a glass containing up to 50 wt % ash can be made using Frit 131 at 1150°C. Based on these tests, a melter the size of the CTD minimelter should be able to vitrify AWI ash as it is produced. 2 tabs.

19348 (EEG–26) **Proposed preoperational environmental monitoring program for WIPP (Waste Isolation Pilot Plant).** Spiegler, P. New Mexico Health and Environment Dept., Santa Fe, NM (USA). Environmental Evaluation Group. Nov 1984. 33p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-89AL58309. Order Number DE90007369. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The purpose of the Environmental Evaluation Group (EEG) is to conduct an independent technical evaluation of the potential radiation exposure to people from the proposed Federal radioactive Waste Isolation Pilot Plant (WIPP) near Carlsbad, in order to protect the public health and safety and ensure that there is minimal environmental degradation. The EEG is part of the Environmental Improvement Division, a component of the New Mexico Health and Environment Department—the agency charged with the primary responsibility for protecting the health of the citizens of New Mexico. The Group is neither a proponent nor an opponent of WIPP. Analyses are conducted are available data concerning the proposed site, the design of the repository, its planned operation, and its long-term stability. These analyses include assessments of reports issued by the US Department of Energy (DOE) and its contractors, other Federal agencies and organizations, as they relate to the potential health, safety and environmental impacts from WIPP. 17 refs., 5 figs., 2 tabs.

19349 (EEG–27) **Sensitivity analysis of solute transport in fractures and determination of anisotropy within the Culebra dolomite.** Rehfeldt, K. New Mexico Health and Environment Dept., Santa Fe, NM (USA). Environmental Evaluation Group. Sep 1984. 52p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-89AL58309. Order Number DE90007368. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

The Waste Isolation Pilot Plant (WIPP) is a U.S. Department of Energy facility for demonstrating the disposal of defense transuranic (TRU) radioactive waste. The WIPP is located approximately 26 miles east of Carlsbad, New Mexico. It lies in the northern part of the Delaware Basin, an oval shaped sedimentary trough nearly surrounded by the Capitan reef. The basin is composed primarily of a thick sequence of evaporites with overlying clastic sedimentary rocks. The major formations of interest in the Delaware Basin at the WIPP site consist, in stratigraphially ascending order, the Castile, Salado, and Rustler Formations and the Dewey Lake Redbeds. The Castile Formation is the basal unit in the evaporite sequence and consists of thick layers of anhydrite and halite. The Castile has been termed anhydrite-rich and is differentiated on this basis from the overlying halite-rich Salado Formation. 23 refs., 11 figs., 7 tabs.

19350 (EGG-M–89333) **A system to control contamination during retrieval of buried TRU [transuranic] waste.** Loomis, G.G.; Menkhaus, D.E.; Scott, D.W. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1990]. 14p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC07-76ID01570. (CONF-900210–10: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90006972. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper discusses design features of a contamination control system for use during retrieval of buried transuranic (TRU) waste at the Idaho National Engineering Laboratory (INEL). Between

1952 and 1970 over 56,000m^3 of primarily Rocky Flats Plant (RFP) generated TRU waste was stored at the INEL in shallow land filled pits and trenches, which consisted of sludges, cloth, paper, metal, wood, concrete, and asphalt contaminated with micron-sized, oxidized particles of plutonium and americium. Retrieval for final disposal is one of the options being considered for this buried waste. 6 refs., 1 fig.

19351 (EGG-M-90001) **Advances in the Department of Energy's Prototypical Consolidation Demonstration Project.** Trohkimoinen, G.R. EG and G Idaho, Inc., Idaho Falls, ID (USA). Jan 1990. 11p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570;AC07-86ID12651. (CONF-900161-4: 7. Institute of Nuclear Materials Management spent fuel management seminar, Washington, DC (USA), 17-19 Jan 1990). Order Number DE90006956. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The United States Department of Energy (DOE) is sponsoring the development and testing of production-scale equipment to perform dry, horizontal consolidation of spent nuclear fuel assemblies at the proposed Monitored Retrievable Storage (MRS) Facility or the High Level Waste (HLW) Repository. These activities are being performed for DOE's Office of Civilian Radioactive Waste Management (OCRWM) under contracts administered by the Department's Idaho Operations Office (DOE-ID). NUS Corporation of Gaithersburg, Maryland, is the contractor for Phase III, Fabrication and Cold Checkout, of the Prototypical Consolidation Demonstration Project (PCDP). EG&G Idaho, Inc., the management and operating contractor at the Idaho National Engineering Laboratory (INEL), is providing technical and quality oversight of NUS and its subcontractors for DOE-ID and procuring Government Furnished Equipment (GFE) to be used in the cold testing program. 1 tab.

19352 (EGG-M-90020) **Identification and characterization of Department of Energy special- case radioactive waste.** Williams, R.E.; Kudera, D.E. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1990]. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC07-76ID01570. (CONF-900210-5: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90006949. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper identifies and characterizes Department of Energy (DOE) special-case radioactive wastes. Included in this paper are descriptions of the special-case waste categories and their volumes and curie contents, as well as discussions of potential methods for management of these special-case wastes. Work on extensive inventories of DOE-titled special-case waste are still in progress.

19353 (EGG-MS-8714) **Helium permeability through austenitic stainless steel.** Anderl, R.A.; Nagata, P.K. EG and G Idaho, Inc., Idaho Falls, ID (USA). Sep 1989. 24p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC07-76ID01570. Order Number DE90007046. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The by-product canister for the Special Isotope Separation Project will be austenitic stainless steel. The by-product produces, among other things, helium gas from alpha particle decay. To determine whether the helium gas pressure will increase with time, the permeability of helium through austenitic stainless steel was calculated using data from the literature. It was found that stainless steel is essentially impermeable to helium at 523 K (250°C), the predicted maximum canister storage temperature. Therefore, based on the estimated helium production rate and the canister volume, the helium gas pressure will increase with time up to about 0.9 atm at the end of the canister's 50-year life. 16 refs., 1 fig.

19354 (EGG-SARE-8767) **Preliminary development and screening of release scenarios for Greater Confinement Disposal of transuranic waste at the Nevada Test Site.** Hertzler, C.L.; Atwood, C.L. EG and G Idaho, Inc., Idaho Falls, ID (USA). Oct 1989. 116p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC07-76ID01570. Order Number DE90007289. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

Preliminary release scenarios for Greater Confinement Disposal (GCD) of transuranic (TRU) waste at the Nevada Test Site (NTS) are developed and, where possible, screened for significance. Scenarios are developed for natural initiating events and processes, events and processes caused by man, and events and processes caused by TRU waste. Significance is assessed on the basis of credibility, probability, or release significance. The scenario development and screening addresses single release events and some multiple release events and is conditional on assumptions concerning disposal design. Of the over 70 scenarios considered, 9 are determined to be not credible at the GCD facility and 27 insignificant for the purpose of disposal performance assessment. The remaining scenarios require further study in order to be evaluated. 87 refs., 12 figs., 6 tabs.

19355 (EGG-SARE-8768) **Status of development and screening of release scenarios for greater confinement disposal of transuranic waste at the Nevada Test Site, September 1989.** Hertzler, C.L. EG and G Idaho, Inc., Idaho Falls, ID (USA). Oct 1989. 86p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90007361. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

Release scenarios for Greater Confinement Disposal of transuranic waste at the Nevada Test Site that are discussed elsewhere are updated based on work performed during fiscal year 1989 and peer review comments. Of the scenarios addressed, 8 will be modeled in disposal performance assessment and 36 are insignificant, not credible, or cannot be evaluated. Twenty-one scenarios remain to be screened; knowledge of waste inventory and required input from the Environmental Protection Agency on expected human activities will be necessary for completion of the work. Completion of the work also involves addressing the possibility of multiple release events, engineered barriers, and uncertainties in scenario evaluations. 28 refs., 6 figs., 2 tabs.

19356 (EGG-SARE-8770) **Statistical analysis of precipitation data from well 5B in area five of the Nevada Test Site.** Harris, G.A. EG and G Idaho, Inc., Idaho Falls, ID (USA). Oct 1989. 30p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC07-76ID01570. Order Number DE90007291. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

From September 1963 to February 1988, the US National Oceanic and Atmospheric Administration measured daily precipitation at Well 5B near the Radioactive Waste Management Site in the Nevada Test Site. This data is analyzed to characterize precipitation in the area to support a model of the infiltration of the water through the vadose zone. Data is characterized on a monthly basis and an annual basis. The characteristics of particular interest were the average daily precipitation, the number of precipitation days, and the total precipitation. 1 ref., 4 figs., 4 tabs.

19357 (EGG-WM-8661) **Environmental Restoration Program: In Situ Vitrification Intermediate Scale Sampling and Analysis Plan.** Ginsburg, J.F. EG and G Idaho, Inc., Idaho Falls, ID (USA). Aug 1989. 56p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90006969. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This Sampling and Analysis Plan (SAP) has been prepared in accordance with the Environmental Restoration Program (ERP) Program Directive (PD) 5.2 to define specific field, laboratory, and quality assurance activities necessary to generate defensible data required to evaluate in situ vitrification (ISV) as an appropriate remedial technology for all or a portion of the Subsurface Disposal Area (SDA). The SDA is located at the Radioactive Waste Management Complex (RWMC) of Idaho National Engineering Laboratory (INEL). This SAP will consider the data needs of operational, engineering, regulatory, and health and safety activities for two "cold" intermediate scale tests scheduled for August 1989 to be conducted outside the fence of the Water Reactor Research Test Facility (WRRTF) site. Separate SAP's will be generated for an engineering scale test to be conducted at Pacific Northwest Laboratory (PNL) in June 1989 and a "hot" large scale test scheduled to be conducted at the SDA in 1991. 7 refs., 5 figs., 2 tabs.

19358 (EGG-WM-8689) **Health and safety plan for operations performed for the Buried Waste Program, Environmental Restoration Program.** Spang, N.W. EG and G Idaho, Inc., Idaho Falls, ID (USA). Aug 1989. 123p. Sponsored by U.S. DOE Nuclear

Energy. DOE Contract AC07-76ID01570. (EGG-WM–8504). Order Number DE90007022. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

The Buried Waste Program (BWP) Health and Safety Plan (HSP) establishes the procedures and provides general guidelines for worker and public safety to be used by EG&G Idaho, Inc. during the Resource Conservation Recovery Act (RCRA)/ Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) investigations being performed at the Radioactive Waste Management Complex (RWMC), Idaho National Engineering Laboratory. The purpose of the BWP investigations is to select, demonstrate, and implement remedial actions that will permanently protect people and the environment from mixed (hazardous and radioactive) waste buried in the Subsurface Disposal Area (SDA) of the RWMC. The Plan applied to EG&G, subcontractors to EG&G, and employees of other firms and DOE Labs working under the technical direction of EG&G at the SDA investigation site. It has been prepared in recognition of and is consistent with NIOSH/OSHA/USCG/EPA Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, October 1985; the EG&G Safety Manual; the EG&G Radiological Controls Manual; and EPA Standard Operating Safety Guides, November 1984. 16 refs., 4 figs., 2 tabs.

19359 (EGG-WM–8775) **Rapid determination of plutonium content on filters and smears using alpha liquid scintillation techniques.** Shaw, P.G. EG and G Idaho, Inc., Idaho Falls, ID (USA). Sep 1989. 56p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90006984. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This paper discusses a technique for rapidly determining plutonium content on filters and smears using Alpha Liquid Scintillation. Filter and smear samples will be analyzed daily for plutonium (Pu^{239}) content during projected waste retrieval operations at the Radioactive Waste Management Complex (RWMC) of the Idaho National Engineering Laboratory. Daily monitoring will allow for trending of airborne and surface contamination. Present analysis techniques are time consuming as both numerous naturally occurring isotopes, such as uranium and thorium daughters, and inert solids must be removed prior to counting to avoid interference with Pu detection. Alpha Liquid Scintillation (ALS) in conjunction with microwave digestion was investigated as a technique for rapid Pu analyses. Advantages offered by ALS are short turnaround time and field use with acceptable accuracy. 13 refs., 7 figs., 5 tabs.

19360 (EGG-WM–8802) **Background ventilation studies for TRU-waste retrieval.** Scott, D.W.; Winberg, M.R. EG and G Idaho, Inc., Idaho Falls, ID (USA). Oct 1989. 42p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC07-76ID01570. Order Number DE90006950. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This report presents results from a series of experiments performed to give engineering background information for a ventilation system that will be used during retrieval of transuranic (TRU) buried waste. The retrieval project is part of the Environmental Restoration Program and will involve a double containment with an inner and outer building. The retrieval of buried wastes within the inner containment building may result in TRU contaminated particulates being suspended in the air. The ventilation system will help remove these contaminated particles. To study the behavior of airborne TRU contaminated particulates in a ventilation flow, a scaled wind tunnel was designed and constructed at INEL. Experiments discussed in this report include: (a) a study of eddy patterns and backflow around a scale-model excavator and dig face, (b) evaluation of innovative filter media as a possible pre-filter to extend the service life of the primary HEPA filters, and (c) a study of deposition of TRU contaminated dust as a function of duct velocity (0–100 fpm). These experiments involved soils contaminated with small amounts of plutonium and americium (500 pCi/g). Results include high speed photographs and video tape of the air pattern experiments and tabulated results and graphs of measured dust mass deposition and radiochemical analysis of samples taken during the pre-filter and downwind deposition experiments. 5 refs., 20 figs., 9 tabs.

19361 (GSF–4/89) **Project documentation of the research on forest decline in the alpine region.** Reuther, M.; Kirchner, M. Gesellschaft fuer Strahlen- und Umweltforschung m.b.H. Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Mar 1989. 241p. (In German). Order Number DE90753304. Available from NTIS (US Sales Only), PC A11/MF A01.

The present project documentation was compiled by the Arge Alp and Arge Alpen Adria on behalf of the respective state governments for the alpine states of Austria, Switzerland, Italy (alpine Italy), and Bavaria (southern Bavaria including the alpine region and the Bayerischer Wald mountains). It covers current research projects in the alpine countries that are financed by different sources. The research projects are listed by countries and in alphabetic order referring to the project leader's name. This is followed by a subject index. Short project descriptions and descriptions of the research sites are to give the interested reader better insight into the current status of research in the field of forest decline and related fields for the alpine region. (orig./MG).

19362 (KFK–4633) **Composition, activity- and heat-inventory of different waste streams from LWR and FBR nuclear fuel cycles.** Hauser, W. (Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Nukleare Entsorgungstechnik); Wenzel, W. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Nukleare Entsorgungstechnik. Oct 1989. 201p. (In German). Order Number DE90753309. Available from NTIS (US Sales Only), PC A10/MF A01.

According to the German concept, spent reactor fuel elements are intended to be reprocessed. The resulting radioactive wastes are planned to be disposed of in a salt dome. Long-term safety analysis for the nuclear waste repository and the evaluation of waste treatment methods require detailed information about the composition, activity- and heat-inventory of the waste streams. In this report data are listed which were calculated for radioactive wastes from reprocessed fuel elements (high-level waste concentrate, medium-level waste concentrate, dissolver residues) and radioactive wastes from the fabrication of nuclear fuel elements. Data are given for the reprocessing and the fabrication of uranium dioxide and uranium/plutonium mixed oxide fuel elements for light-water reactors. In addition the corresponding waste streams from a fast breeder reactor nuclear fuel cycle are characterized. For the calculations the KORIGEN-code was used with input data for reference-type reactors. The calculation of the time dependent radionuclide composition of the wastes was based on element separation factors which were experimentally determined. (orig.).

19363 (LA–11695) **Cobalt (III) dicarbollide: A potential ^{137}Cs and ^{90}Sr waste extraction agent.** Reilly, S.D. (Reed Coll., Portland, OR (USA)); Mason, C.F.V.; Smith, P.H. Los Alamos National Lab., NM (USA). Feb 1990. 20p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. Order Number DE90007376. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Cobalt(III) dicarbollide is a potentially superior reagent for extracting ^{137}Cs, ^{90}Sr, and possibly other fission products from high-level nuclear waste. Properties such as its high resistance to acids and radiation and reports of its selective extraction of $^{137}Cs^{+}$ and $^{90}Sr^{2+}$ from long-lived fission products indicate Co dicarbollide's potential merit. The selectivity could be beneficial in two ways: it could extract fission products of such purity that they could be useful for current and potential applications, and it could create a smaller volume of toxic residual waste that would be easier to handle and store. The large amount of high-level radioactive waste in the United States and abroad requires large-scale extraction, for which feasible or practical methods do not currently exist. Researchers in the US have tried systems using agents such as macrocyclic polyether extractants and ferrocyanide ion exchangers, which have significant drawbacks. Cobalt dicarbollide also has drawbacks, possible economic, but studies of its extractive qualities and recycling possibilities may well resolve these shortcomings. Cobalt dicarbollide was first synthesized in the United States, but ironically, the US has largely avoided serious studies of

the compound for use as an extractant while the open literature shows that Czechoslovakia and the USSR have devoted extensive effort and money to such work. Synthesis of 300 kg of the reagent by a Czech chemical firm indicates that the Czechs and Russians have already begun to investigate the use of the compound on a large scale. Several issues must still be resolved and much research must be conducted before Co dicarbollide can be used in a full-scale waste processing plant. However, the merits described in this paper suggest that it deserves careful, detailed studies by the United States. 39 refs., 6 figs., 4 tabs.

19364 (LA-UR–90-13) **Role of underground testing to determine suitability of Yucca Mountain as a potential repository site.** Kalia, H.N. Los Alamos National Lab., NM (USA). 1990. 9p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-7405-ENG-36. (CONF-900406–26: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90006486. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A brief description of the Exploratory Shaft based site characterization testing program for the Yucca Mountain Project of the permanent disposal of high level radioactive waste is briefly described in this paper. Details of the testing program are presented in the DOE-issued Site Characterization Plan. Overview of the current planning process and status of various activities is briefly described. This study will reevaluate the mining method, ESF location and any changes in the ESF testing program. 2 refs., 2 figs., 1 tab.

19365 (LA-UR–90-68) **Thermal stability of zeolitic tuff from Yucca Mountain, Nevada.** Bish, D.L. Los Alamos National Lab., NM (USA). Apr 1990. 7p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-7405-ENG-36. (CONF-900406–25: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90007826. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Thermal models of the proposed repository at Yucca Mountain, Nevada, suggest that rocks near the proposed host rock will experience elevated temperatures for at least 1000 yrs. In order to assess the effects of elevated temperatures on zeolites clinoptilolite and mordenite were investigated using a combination of high-temperature X-ray powder diffraction, thermogravimetric and differential scanning calorimetric analysis, and long-term heating experiments. 13 refs., 7 figs.

19366 (LA-UR–90-183) **Prototype testing for the Yucca Mountain Project.** Kalia, H.N. (Los Alamos National Lab., NM (USA)); Oliver, R.D.; Girdley, W.A. Los Alamos National Lab., NM (USA). 1990. 8p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-7405-ENG-36. (CONF-900406–24: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90006503. Available from NTIS, PC A03/MF A01; OSTI; INIS.

The US Department of Energy, through its Yucca Mountain Project Office, has been conducting prototype activities in welded and non-welded tuff. These activities are in preparation for characterization of the Yucca Mountain area, which is under consideration as a site for a geologic repository in which high-level nuclear waste could be safely stored. Investigators from organizations that will conduct the site investigation have been afforded opportunity, through the prototype program, to test, evaluate, and develop instruments, equipment, and methods. The Exploratory Shaft Facility will be used to collect significant amounts of underground site characterization data. The prototype tests are conducted under similar conditions. 3 refs., 4 figs.

19367 (LA-UR–90-351) **Simulation of heat transfer in the unsaturated zone.** Zyvoloski, G. Los Alamos National Lab., NM (USA). [1990]. 16p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-7405-ENG-36. (CONF-900406–27: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90006512. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Heat transfer can play an important role in fluid flow near the emplacement site of high-level nuclear waste. The effects on far-field flow can be important in understanding net moisture fluxes above the repository zone. The convection in the unsaturated zone at the Yucca Mountain site was responsible for this movement. If this is so, then the convection could provide a mechanism for drying the rock above the repository zone and thus provide a buffer for heavy rainfall events. In addition, the convection would increase the movement of gaseous radionuclides such as $^{14}CO_2$, tritiated water vapor, and ^{129}I (Weeks, 1987). Because of the complexity of the problem, numerical models were required to calculate gas flow and vapor transport at the site. Kipp previously modeled this problem using the code HST3D. This code represents the flow of a single-phase fluid with both heat- and mass-transfer effects included. Water density and partial pressure effects are accounted for by the virtual temperature method. In this paper, the problem was simulated using the code FEHMN, a finite-element heat- and mass-transfer code being developed for the Yucca Mountain Project. The work described in this paper was done in preparation of the upcoming problem to be formulated for the Performance Assessment Calculation Exercise. 5 refs., 9 figs., 1 tab.

19368 (LA-UR–90-353) **Simulation of radionuclide retardation at Yucca Mountain using a stochastic mineralogical/geochemical model.** Birdsell, K.H.; Campbell, K.; Eggert, K.; Travis, B.J. Los Alamos National Lab., NM (USA). [1990]. 19p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-7405-ENG-36. (CONF-900406–28: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90006513. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper presents preliminary transport calculations for radionuclide movement at Yucca Mountain. Several different realizations of spatially distributed sorption coefficients are used to study the sensitivity of radionuclide migration. These sorption coefficients are assumed to be functions of the mineralogic assemblages of the underlying rock. The simulations were run with TRACRN[1], a finite-difference porous flow and radionuclide transport code developed for the Yucca Mountain Project. Approximately 30,000 nodes are used to represent the unsaturated and saturated zones underlying the repository in three dimensions. Transport calculations for a representative radionuclide cation, ^{135}Cs, and anion, ^{99}Tc, are presented. Calculations such as these will be used to study the effectiveness of the site's geochemical barriers at a mechanistic level and to help guide the geochemical site characterization program. The preliminary calculations should be viewed as a demonstration of the modeling methodology rather than as a study of the effectiveness of the geochemical barriers. The model provides a method for examining the integration of flow scenarios with transport and retardation processes as currently understood for the site. The effects on transport of many of the processes thought to be active at Yucca Mountain may be examined using this approach. 11 refs., 14 figs., 1 tab.

19369 (NUKEM-FuE–88042) **Conditioning of ashes from incineration plant in special furnaces. Final report.** Ganser, B. Nuklear-Chemie und -Metallurgie G.m.b.H. (NUKEM), Hanau (Germany, F.R.); Commission of the European Communities, Brussels (Belgium). Directorate General for Science, Research and Development; Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). 1988. 97p. (In German). Contract EC FI1W-0010-D(B);BMFT KWA 76061. Order Number DE90753305. Available from NTIS (US Sales Only), PC A05/MF A01.

In this report we describe the development of a melting process for radioactive ashes. After a literature survey about the state of the art and investigated ash compositions the in-can-melting was elected for further work. Based on literature data lab experiments with inactive simulates were performed to investigate different additives (net work formers and transformers) for melting point reduction. Na-Tetraborate was most effective. An addition of 50% by weight (concerning ash weight) was sufficient to melt all simulates at 1000^{0}C. The products showed similar low leach rates like vitrified HAW. With two different melting furnaces (Naber, LINN) full scale experiments were performed. The results were not quite sufficient because of uncomplete melting (Naber) resp. unsufficient

operation (LINN). Nevertheless the results of the lab experiments could be nearly verified (Compressive strength 60-160 N/mm^2, Diffusion coefficient for Boron E-17 - E-19 m^2/s). Based on the technical experiments a plant was designed for hot operation. A cost estimation for conditioning and final disposal amounted to 19 DM/kg ash. (orig.).

19370 (NUREG/CR–5482) **Laboratory analysis of fluid flow and solute transport through a variably saturated fracture embedded in porous tuff.** Chuang, Y. (Arizona Univ., Tucson, AZ (USA). Dept. of Hydrology and Water Resources); Haldeman, W.R.; Rasmussen, T.C.; Evans, D.D. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; Arizona Univ., Tucson, AZ (USA). Dept. of Hydrology and Water Resources. Feb 1990. 330p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A15/MF A01 - GPO - OSTI.

Laboratory techniques are developed that allow concurrent measurement of unsaturated matrix hydraulic conductivity and fracture transmissivity of fractured rock blocks. Two Apache Leap tuff blocks with natural fractures were removed from near Superior, Arizona, shaped into rectangular prisms, and instrumented in the laboratory. Porous ceramic plates provided solution to block tops at regulated pressures. Infiltration tests were performed on both test blocks. Steady flow testing of the saturated first block provided estimates of matrix hydraulic conductivity and fracture transmissivity. Fifteen centimeters of suction applied to the second block top showed that fracture flow was minimal and matrix hydraulic conductivity was an order of magnitude less than the first block saturated matrix conductivity. Coated-wire ion-selective electrodes monitored aqueous chlorided breakthrough concentrations. Minute samples of tracer solution were collected with filter paper. The techniques worked well for studying transport behavior at near-saturated flow conditions and also appear to be promising for unsaturated conditions. Breakthrough curves in the fracture and matrix, and a concentration map of chloride concentrations within the fracture, suggest preferential flows paths in the fracture and substantial diffusion into the matrix. Average travel velocity, dispersion coefficient and longitudinal dispersivity in the fracture are obtained. 67 refs., 54 figs., 23 tabs.

19371 (ORNL/FTR–3526) **[Radwaste incineration and related off-gas treatment operations]: Foreign trip report, January 13–February 3, 1990.** Singh, S.P.N. Oak Ridge National Lab., TN (USA). 20 Feb 1990. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90007235. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

At the request of the International Atomic Energy Agency (IAEA), technical assistance was provided to the Korea Atomic Energy Research Institute (KAERI) in the field of radwaste incineration and related off-gas treatment operations. The traveler provided the requested technical consultations and, in the process, obtained an understanding of the Republic of Korea's plans for the management of the wastes from the country's nuclear power plants and research facilities. The government of the Republic of Korea has tasked KAERI to develop the facilities for treating and disposing of the wastes from the country's nuclear facilities in an environmentally responsible manner. As a step in that direction, the Radwaste Treatment Department at KAERI is developing the technology and the plans for the incineration of burnable low-level radwaste, which comprises about 35% of the wastes generated by the nuclear facilities. The incineration program at KAERI appears to be well planned. 4 refs., 2 figs.

19372 (ORNL/TM–10742) **Cross flow filtration of Oak Ridge National Laboratory liquid low-level waste.** Fowler, V.L.; Hewitt, J.D. Oak Ridge National Lab., TN (USA). Dec 1989. 37p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-84OR21400. Order Number DE90005817. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A new method for disposal of Oak Ridge National Laboratory liquid low-level radioactive waste is being developed as an alternative to hydrofracture. The acceptability of the final waste form rests in part on the presence or absence of transuranic (TRU) isotopes. Inertial cross flow filtration was used in this study to determine the potential of this method for separation of the TRU isotopes from the bulk liquid stored in the Melton Valley Storage Tanks. 7 refs., 11 figs., 5 tabs.

19373 (ORNL/TM–11407) **Sensitivity analysis of EQ3.** Horwedel, J.E.; Wright, R.Q.; Maerker, R.E. Oak Ridge National Lab., TN (USA). Jan 1990. 52p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE90006442. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A sensitivity analysis of EQ3, a computer code which has been proposed to be used as one link in the overall performance assessment of a national high-level waste repository, has been performed. EQ3 is a geochemical modeling code used to calculate the speciation of a water and its saturation state with respect to mineral phases. The model chosen for the sensitivity analysis is one which is used as a test problem in the documentation of the EQ3 code. Sensitivities are calculated using both the CHAIN and ADGEN options of the GRESS code compiled under G-float FORTRAN on the VAX/VMS and verified by perturbation runs. The analyses were performed with a preliminary Version 1.0 of GRESS which contains several new algorithms that significantly improve the application of ADGEN. Use of ADGEN automates the implementation of the well-known adjoint technique for the efficient calculation of sensitivities of a given response to all the input data. Application of ADGEN to EQ3 results in the calculation of sensitivities of a particular response to 31,000 input parameters in a run time of only 27 times that of the original model. Moreover, calculation of the sensitivities for each additional response increases this factor by only 2.5 percent. This compares very favorably with a running-time factor of 31,000 if direct perturbation runs were used instead. 6 refs., 8 tabs.

19374 (ORNL/TM–11416) **Supplemental data package for the Low-Level Waste Disposal Development and Demonstration Program: Data collection period, April 1988–September 1989.** Truett, L.F.; Ketelle, R.H. Oak Ridge National Lab., TN (USA). Dec 1989. 422p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-84OR21400. Order Number DE90005816. Available from NTIS, PC A18/MF A01; OSTI; INIS; GPO Dep.

This data package is the final report of data that were collected between April 1988 and September 1989 at each of four sites: Solid Waste Storage Area 7, West Bear Creek Valley, West Chestnut Ridge, and East Chestnut Ridge. This report contains water table elevation data, precipitation data, surface water discharge data, and results of water quality analyses. Specific dates for each data type collected are given in the appropriate sections. The sections are organized by site. This report will support an Environmental Impact Statement, the purpose of which is to evaluate the effects of future disposal of low-level waste at these four sites on the Oak Ridge Reservation. 1 ref., 13 figs., 70 tabs.

19375 (PNL–6640-Vol.2) **Storage of LWR [light-water-reactor] spent fuel in air: Volume 2, Microstructural characterization of low-temperature oxidized LWR spent fuel.** Thomas, L.E. (Pacific Northwest Lab., Richland, WA (USA)); Charlot, L.A.; Coleman, J.E.; Knoll, R.W. Pacific Northwest Lab., Richland, WA (USA). Dec 1989. 98p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC06-76RL01830. Order Number DE90006477. Available from NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

An experimental program is being conducted at Pacific Northwest Laboratory (PNL) to determine the oxidation response of light-water-reactor (LWR) spent fuels under conditions appropriate to fuel storage in air. The program is designed to investigate several independent variables that might affect the oxidation behavior of spent fuel. Included are temperature (135 to 230°C), fuel burnup (to about 34 MWd/kgM), reactor type (pressurized and boiling water reactors), moisture level in the air, and the presence of a high gamma field. In continuing tests with declad spent fuel and nonirradiated UO_2 specimens, oxidation rates were monitored by weight-gain measurements and the microstructures of subsamples taken during the weighing intervals were characterized by several analytical methods. The oxidation behavior indicated by weight gain and time to form powder will be reported in Volume III of this series. The characterization results obtained from x-ray diffractometry, transmission electron microscopy, scanning electron

microscopy, and Auger electron spectrometry of oxidized fuel samples are presented in this report. 28 refs., 21 figs., 3 tabs.

19376 (PNL–7222-Vols.1-2) **Resource Conservation and Recovery Act ground-water monitoring projects for Hanford Facilities: Progress report, July 1–September 30, 1989: Volume 1, Text: Volume 2, Appendices.** Smith, R.M.; Bates, D.J.; Lundgren, R.E. Pacific Northwest Lab., Richland, WA (USA). Dec 1989. 334p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC06-76RL01830. Order Number DE90007499. Available from NTIS, PC E13/MF E01; OSTI; INIS; GPO Dep.

This report contains 4 sheets of microfiche supplements.

This is Volume 1 of a two-volume document that describes the progress of 14 Hanford Site ground-water monitoring projects for the period July 1 to September 30, 1989. This volume discusses the projects; Volume 2 provides as-built diagrams, completion/inspection reports, drilling logs, and geophysical logs for wells drilled, completed, or logged during this period. Volume 2 can be found on microfiche in the back pocket of Volume 1. The work described in this document is conducted by the Pacific Northwest Laboratory under the management of Westinghouse Hanford Company for the US Department of Energy. Concentrations of ground-water constituents are compared to federal drinking water standards throughout this document for reference purposes. All drinking water supplied from the sampled aquifer meets regulatory standards for drinking water quality.

19377 (PSI–44) **Investigation of corrosion in the development of decontamination solutions for nuclear systems.** Wiedemann, K.H. (Paul Scherrer Inst. (PSI), Wuerenlingen (Switzerland). Lab. fuer Werkstoffe und Nukleare Verfahren (Switzerland)). Paul Scherrer Inst. (PSI), Wuerenlingen (Switzerland). Sep 1989. 26p. (In German). Available from Published also in Werkstoffe u. Korrosion v. 39 p. 185-192, 283-286, 332-338 (1988), v. 40 p. 441-447 (1989).

The corrosion behaviour of some nuclear materials has been investigated in two types of decontamination solutions - an acid and an alkaline redox system. In both types of solutions the dissolution of the metal is regular for the steels as well as for Nimonic 80A, while it is uneven in the case of TZM. Because of their capability to dissolve the radionuclide-containing oxide layers on nickel-chromium alloys, aqueous solutions of fluorboric acid, silicofluoric acid, and potassium silico-fluoride are suitable for decontaminating high temperature gas turbine materials. In decontamination solutions of the type formic acid-formaldehyde, ferritic steels undergo heavy pitting corrosion or shallow pitting corrosion. The addition of formaldehyde to formic acid solutions scarcely influences the temperature dependency of the corrosion rates, the solution specific corrrosion rates, however, increase with increasing carbon content of the steels. The high corrosion rates can be reduced by about two orders of magnitude by adding inhibitors, but pitting corrosion is unavoidable. For decontaminating components of nuclear plants, the radionuclide-containing surface layers are frequently pre-treated with an oxidizing solution, and then removed with a reducing solution. In an acid post-treament solution the ferritic steel 21 CrMoV 5 II shows relatively high corrosion rates, while austenitic steels and nickel-chromium alloys are not corroded due to passivation. In an alkaline solution the mild steel as well as the austenitic steels and the nickel-chromium alloys investigated form metastable-passive systems. (author) 43 figs., 9 tabs., 20 refs.

19378 (RFP–4388) **LECO crucible recovery: A review of processing options.** Kirchner, J.F. Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant. Aug 1986. 24p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP03533. Order Number DE90007292. Available from NTIS, PC A - OSTI; GPO Dep.

A review of previous work was made to determine a process for recovering plutonium from LECO crucible residue. Processes are available for recovering residue containing copper, tin, or iron accelerators. Two processes, one a nitric acid system and one a hydrochloric acid system, are presented. Neither method provides an efficient recovery of plutonium from the residue. Development work is suggested for improving these systems and determining processes for recovery of plutonium from tungsten accelerated residues.

19379 (RHO-BWI-SA–140) **Analysis of host rock performance for a nuclear waste repository using coupled flow and transport models.** Baca, R.G. (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations); Langford, D.W.; England, R.L. Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations. Nov 1981. 9p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC06-77RL01030. (CONF-810861–5: OECD Nuclear Energy Agency workshop on near-field phenomena in geologic respositories for radioactive waste, Seattle, WA (USA), 31 Aug - 3 sep 1981). Available from OSTI; INIS.

Numerical models were recently developed for simulation of coupled flow and transport processes in the near-field zone of a deep geologic repository. These models are currently being applied to a reference repository location in the Columbia River basalt at the Hanford Site in Washington State. This paper presents results from some preliminary computer model simulations carried out to evaluate host rock performance. Conclusions are drawn with regard to the most important physical processes and geohydrological properties determining the degree of waste isolation achieved by the repository system. 10 refs., 3 figs., 1 tab.

19380 (RHO-BWI-SA–312) **Application of finite-element models in the evaluation of engineered barriers for a mined geologic repository.** Baca, R.G. (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations); Sonnichsen, J.C.; Altenhofen, M.K.; Langford, D.W. Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations. Mar 1984. 15p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC06-77RL01030. (CONF-840688–3: 5. international conference on finite elements in water resources, Burlington, VT (USA), 18-22 Jun 1984). Available from OSTI; INIS.

In this paper, we describe a finite-element simulation approach that is being used to evaluate and compare waste emplacement geometries for a repository in a basalt geology. The approach is based on the use of a deterministic fluid flow model to predict groundwater movement as a function of hydraulic properties and the thermal regime and a stochastic transport model to predict long-term migration of radionuclides. The simulation results summarized herein represent a preliminary evaluation of relative performance for two proposed barrier designs. 10 refs., 2 figs.

19381 (RHO-BW-SA–297) **Modeling fluid flow in fractured-porous rock masses by finite-element techniques.** Baca, R.G. (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations); Arnett, R.C.; Langford, D.W. Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations. Apr 1983. 28p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC06-77RL01030. Available from OSTI; INIS.

One of the major difficulties of modeling fluid flow processes in hard-rock geologies is the complex nature of the porosity systems. Hydraulic behavior in these rock masses is characterized by both porous and fractured interflow zones. Traditionally, fractured-porous rocks have been modeled as an equivalent porous medium or as a system of fractures separated by impermeable blocks. A new method is proposed that unifies these two approaches for modeling fluid flow processes in fractured-porous media. The basic idea is to use a combination of isoparametric elements for the porous zones and line elements for the fractures. The coupling between the governing equations for each element type is achieved using the superposition principle. The effectiveness of the new approach is demonstrated by comparing numerical solutions with known solutions for problems of flow and solute transport in fractured-porous media.

19382 (SAND–88-0882) **Mineralogic and chemical data supporting heat capacity determination for tuffaceous rocks.** Connolly, J.R. (New Mexico Univ., Albuquerque, NM (USA). Dept. of Geology); Nimick, F.B. Sandia National Labs., Albuquerque, NM (USA). Feb 1990. 70p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC04-76DP00789. Order Number DE90006368. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

Bulk chemical, x-ray diffraction, and petrologic data are presented for 20 samples of tuffaceous rocks from Yucca Mountain, Nevada.

Uncertainties are presented for quantitative results (bulk chemistry and point-counting results) but have not been estimated for the semiquantitative x-ray diffraction data. 6 refs., 2 figs., 2 tabs.

19383 (SAND–88-2845C) **Data quality assurance controls through the WIPP [Waste Isolation Pilot Plant] in situ data acquisition, analysis, and management system.** Munson, D.E. (Sandia National Labs., Albuquerque, NM (USA)); Ball, J.R.; Jones, R.L. Sandia National Labs., Albuquerque, NM (USA). [1990]. 14p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900406–17: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90005954. Available from NTIS, PC A03/MF A01 - OSTI.

Assurance of data quality for the in situ tests fielded at the Waste Isolation Pilot Plant is of critical importance. These tests supply the information for development and verification of the technology required for construction of a radioactive waste repository in bedded salt. The tests are some of the largest ever fielded in an underground facility. To assure that the extensive output generated by the tests is compatible with the high standards of quality required, a major project task was undertaken for the acquisition, control, and preservation of all the associated in situ test databases, with the principal emphasis on the very large thermal/structural in situ tests. In order to accomplish this task the WIPP In Situ Data Acquisition, Analysis, and Management System was put into place. The system provides for quality control of the test databases and certified test data throughout the duration of the tests. 13 refs., 14 figs., 3 tabs.

19384 (SAND–89-2018C) **Computed distributions of residual shaft drilling and construction water in the exploratory facilities at Yucca Mountain, Nevada.** Eaton, R.R.; Peterson, A.C. Sandia National Labs., Albuquerque, NM (USA). [1989]. 9p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC04-76DP00789. (CONF-900406–5: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90004210. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The Yucca Mountain Project is studying the feasibility of constructing a high-level nuclear waste repository at Yucca Mountain in southwest Nevada. One activity of site characterization is the construction of two exploratory shafts. This paper contains the results of engineering analytical calculations of the potential distribution of residual construction water in the exploratory shafts and drifts and numerical calculations of the movement of the residual water and how the movement is affected by drift ventilation. In all cases the increase in rock saturation resulting from the construction water was extremely small. 11 refs., 15 figs., 1 tab.

19385 (SAND–89-2026C) **Aerosol particle transport modeling for preclosure safety studies of nuclear waste repositories.** Gelbard, F. (Sandia National Labs., Albuquerque, NM (USA)). Sandia National Labs., Albuquerque, NM (USA). [1989]. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900406–1: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE89016496. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

An important concern for preclosure safety analysis of a nuclear waste repository is the potential release to the environment of respirable aerosol particles. Such particles, less than 10 μm in aerodynamic diameter, may have significant adverse health effects if inhaled. To assess the potential health effects of these particles, it is not sufficient to determine the mass fraction of respirable aerosol. The chemical composition of the particles is also of importance since different radionuclides may pose vastly different health hazards. Thus, models are needed to determine under normal and accident conditions the particle size and the chemical composition distributions of aerosol particles as a function of time and of position in the repository. In this work a multicomponent sectional aerosol model is used to determine the aerosol particle size and composition distributions in the repository. A range of aerosol mass releases with varying mean particle sizes and chemical compositions is used to demonstrate the sensitivities and uncertainties of the model. Decontamination factors for some locations in the repository are presented. 8 refs., 1 tab.

19386 (SAND–89-2050C) **Initiating event identification and screening for nuclear waste repository preclosure risk assessment.** Harris, P.A. (HLB Advanced Technology, Del Mar, CA (USA)); Bolig, C.A.; Brown, T.D. Sandia National Labs., Albuquerque, NM (USA). [1990]. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900406–8: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90005401. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper describes a method to identify potential initiating events that might occur during the preclosure phase at a nuclear waste repository proposed for the Yucca Mountain area of Nevada. Initiating events of interest must be theoretically capable of causing radiological exposure hazards to either repository operations personnel or to the general public. 8 refs., 1 fig.

19387 (SAND–89-2073C) **Preliminary methodology for design of stable drifts for the Yucca Mountain Project.** Bauer, S.J. (Sandia National Labs., Albuquerque, NM (USA)); Ehgartner, B.L.; Hardy, M.P. Sandia National Labs., Albuquerque, NM (USA). [1989]. 10p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC04-76DP00789. (CONF-900406–16: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90005597. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This paper defines a methodology and criteria by which the stability of underground repository drifts in tuff is determined and from which the ground support system is designed. Preconstruction evaluations of stability are required for planning and to support the license application process. The emphasis is on analytical numerical methods because, at this time, empirical data are generally not available for excavations in welded tuff at elevated temperatures or in seismic environments. Observational methods are only applicable during construction. The methodology suggests analytical techniques for the range of structural conditions of the rock currently expected at the Yucca Mountain site: systematically jointed rock masses, randomly jointed rock masses, and widely spaced discrete joints. The analyses must also load on the rock in the vicinity of excavations that result from in situ stresses, thermal expansion, and seismic events. Large-scale field experiments at the Exploratory Shaft Facility (ESF), and laboratory experiments on ESF samples define the controlling deformation mechanisms and allows evaluation of in situ properties, the methodology presented is expected to evolve. 2 refs., 2 figs.

19388 (SAND–89-2098C) **Concepts in prototype testing for in situ geomechanical investigations at Yucca Mountain.** Luke, B.A.; Finley, R.E. Sandia National Labs., Albuquerque, NM (USA). [1989]. 10p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC04-76DP00789. (CONF-900406–15: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90005596. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Geomechanical investigations comprise a significant portion of the site characterization program to be conducted at Yucca Mountain. The investigations will include a number of large-scale experiments that will be conducted in an exploratory shaft facility at the site. A program of prototype testing has been initiated to ensure the success of these expensive and complex experiments. The prototype testing program addresses three problems in rock mechanics: measurement of rock-mass strength, measurement of joint properties in situ, and measurement of rock-mass response to thermally-induced loading. Active areas of development in support of these tests include cutting deep, narrow slots in rock and fabricating high-pressure flatjacks. 7 refs., 3 figs.

19389 (SAND–89-2099C) **Synthesis of studies for the potential of fault rupture at the proposed surface facilities, Yucca Mountain, Nevada.** Gibson, J.D. (Sandia National Labs., Albuquerque, NM (USA)); Shephard, L.E.; Swan, F.H.; Wesling, J.R.; Kerl, F.A. Sandia National Labs., Albuquerque, NM (USA). [1989]. 15p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC04-76DP00789. (CONF-900406–10: International

conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90005238. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Published data for the Midway Valley area, suggest that since middle Miocene time, recognized regional faults have had average slip rates of less than 0.10 mm/yr. Slip rates in the last 8 Ma are estimated to be one-sixth of previous slip rates or less. The decrease in fault activity coincides with the waning of magmatism related to the Paintbrush tuff. Two important uncertainties are inherent in the slip rate estimates: the relative amount of strike-slip versus dip-slip displacement and the errors in precision of dating offset units. Reliable Quaternary slip rates and recurrence intervals are not yet available for the Midway Valley area. The apparent lack of fault scarps in alluvium, however, indicates that no important displacements have occurred in Holocene time, although several photolineaments have been identified. 18 refs., 4 figs., 2 tabs.

19390 (SAND–89-2349C) **An innovative cask for transporting defense high-level waste.** Falci, F.P. (USDOE, Washington, DC (USA)); Allen, G.C.; Madsen, M.M.; Zimmer, A.; Golliher, K.G. Sandia National Labs., Albuquerque, NM (USA). [1989]. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900406–3: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90006538. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

In the early 1980s, the US Department of Energy/Defense Programs (DOE/DP) initiated a project to develop a safe and efficient transportation system for defense high-level waste (DHLW). Sandia National Laboratories (SNL) provides a technical oversight and test support and General Atomics provides the design and safety analysis of the shipping system. The specific activities include designing, testing, certifying and fabricating a legal-weight truck cask system for DHLW canisters that are expected to be first produced by the Defense Waste Processing Facility (DWPF) at the Savannah River Plant (SRP) in South Carolina and later produced by facilities in Washington and Idaho. A truck cask was selected in order to provide a flexible capability for transporting vitrified waste to support a variety of expected experimental program needs. The first planned shipping campaign was to transport a limited number of DHLW canisters from South Carolina to the Waste Isolation Pilot Plant (WIPP) in New Mexico. However, changes in experimental program plans the passage of the Nuclear Waste Policy Act in late 1982, and the subsequent decision to have DHLW permanently placed in the eventual civilian repository resulted in revisions to the mission of the cask development program funded by DOE/DP. 15 refs.

19391 (SAND–89-3047C) **Method for determining the fuel contribution to the source term in transport casks.** Rashid, Y.R. (ANATECH Research Corp., La Jolla, CA (USA)); Lake, W.H.; Sanders, T.L. Sandia National Labs., Albuquerque, NM (USA). [1989]. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900406–19: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90006042. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Detailed models and analytical procedures are applied to the many complex aspects of spent fuel in transport including characterization of the fuel's irradiation conditions and initial states at the time of shipment, determination of the dynamic forces on the fuel assemblies that result from regulatory transportation accidents, modeling and analysis of the fuel's mechanical response to these forces, and estimation of the releasable radioactivity in the event of cladding breach. The methodology adopts a combined deterministic/probabilistic analysis approach in which each aspect of the problem is appropriately treated on the basis of its level of determinability. The results are obtained in the form of failure probabilities for each regulatory event considered. 3 refs., 6 figs.

19392 (SAND–89-3069C) **Important factors in developing a nuclear waste management system.** Hunter, T.O. Sandia National Labs., Albuquerque, NM (USA). [1989]. 5p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC04-76DP00789. (CONF-900406–14: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90005595. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A nuclear waste management system presents a challenge to organize a development program that can effectively achieve the goal of providing timely solutions to the problem of nuclear waste management. A few distinguishing factors can serve to aid the establishment of an effective program.

19393 (SAND–89-7019C) **Deposition of airborne particles from fractured spent fuel or high-level waste.** Ma, C.W. (Bechtel Corp., San Francisco, CA (USA)); Zavoshy, S.J.; Jardine, L.J. Sandia National Labs., Albuquerque, NM (USA). 1989. 25p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC04-76DP00789. (CONF-900406–21: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90006047. Available from NTIS, PC A03/MF A01; OSTI; INIS.

This paper describes a study to estimate the deposition of airborne particles either within a hot cell or outside the building as they are dispersed through the atmosphere, and the extent to which these depositions reduce the offsite dose at the site boundary. 12 refs., 3 figs., 5 tabs.

19394 (SAND–89-7087) **Annotated bibliography of paleoclimate studies relevant to the Waste Isolation Pilot Plant, southeastern New Mexico.** Bachman, G.O. (Bachman (George O.), Albuquerque, NM (USA)). Sandia National Labs., Albuquerque, NM (USA). Sep 1989. 32p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Contract 48-8558. Order Number DE90006369. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A selective, partially annotated bibliography on paleoclimate literature (through 1984) presents the various interpretations of the nature of past climate in New Mexico and adjacent areas in the Southwest. Groundwater flow and concomitant dissolution of evaporites in the Delaware Basin of southeastern New Mexico, the geologic setting of the Waste Isolation Pilot Plant (WIPP) site, has occurred since Permian deposition and may be continuing at some places in the basin. An understanding of patterns of past rainfall may contribute to an understanding of the history of groundwater flow and evaporite dissolution at and near the WIPP site and may help to predict the relative magnitudes of groundwater flow and evaporite dissolution to be expected during the required period of repository performance. Although most references in this list are annotated and pertain to paleoclimate in the vicinity of New Mexico, other references have been included that (1) place the Southwest in the context of world climatic change, (2) pertain to principles and methods of collecting climatic data for past geologic time, and (3) complement such a collection of references because of their historic interest. 35 refs.

19395 (SAND–90-7010C) **Low-level radioactive waste involved in transportation events.** Cashwell, C.E. (G2vanTel Ltd., Albuquerque, NM (USA)). Sandia National Labs., Albuquerque, NM (USA). [1990]. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900210–22: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90007562. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Radioactive Materials Incident Report (RMIR) database contains information about radioactive materials transportation accidents and incidents that have occurred in the United States from 1971 through 1989. Using data from RMIR, this paper will provide detailed information on transportation accidents and incidents that have occurred with low-level radioactive wastes. Additionally, overview data on the number of transport accidents and incidents that have occurred and by what transport mode will also be provided. 4 refs., 6 tabs.

19396 (UCID–21362-OVERVIEW) **Survey of degradation modes of candidate materials for high-level radioactive-waste disposal containers: Overview.** Farmer, J.C.; McCright, R.D.; Kass, J.N. Lawrence Livermore National Lab., CA (USA). Jun

1988. 37p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-7405-ENG-48. Order Number DE90006330. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Three iron- to nickel-based austenitic alloys and three copper-based alloys are being considered as candidate materials for the fabrication of high-level radioactive-waste disposal containers. The austenitic alloys are Types 304L and 316L stainless steels and the high-nickel material Alloy 825. The copper-based alloys are CDA 102 (oxygen-free copper), CDA 613 (Cu-7Al), and CDA 715 (Cu-30Ni). Waste in the forms of both spent fuel assemblies from reactors and borosilicate glass will be sent to the prospective repository at Yucca Mountain, Nevada. The decay of radionuclides will result in the generation of substantial heat and gamma radiation. Container materials may undergo any of several modes of degradation in this environment, including undesirable phase transformations due to a lack of phase stability; atmospheric oxidation; general aqueous corrosion; pitting; crevice corrosion; intergranular stress corrosion cracking; and transgranular stress corrosion cracking. Problems specific to welds, such as hot cracking, may also occur. A survey of the literature has been prepared as part of the process of selecting, from among the candidates, a material that is adequate for repository conditions. The modes of degradation are discussed in detail in the survey to determine which apply to the candidate alloys and the extent to which they may actually occur. The eight volumes of the survey are summarized in Sections 1 through 8 of this overview. The conclusions drawn from the survey are also given in this overview.

19397 (UCID–21362-Vol.1) **Survey of degradation modes of candidate materials for high-level radioactive-waste disposal containers: Volume 1, Phase stability.** Bullen, D.B. (Science and Engineering Associates, Inc., Pleasanton, CA (USA)); Gdowski, G.E. Lawrence Livermore National Lab., CA (USA). Aug 1988. 36p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-7405-ENG-48. Order Number DE90006335. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Three copper-based alloys and three iron- to nickel-based austenitic alloys are being considered as possible materials for fabrication of high-level radioactive-waste disposal containers. The waste will include spent fuel assemblies from reactors as well as high-level waste in borosilicate glass and will be sent to the prospective site at Yucca Mountain, Nevada, for disposal. The copper-based alloy materials are CDA 102 (oxygen-free copper), CDA 613 (Cu-7Al), and CDA 715 (Cu-30Ni). The austenitic materials are Types 304L and 316L stainless steels and Alloy 825. The waste-package containers must maintain substantially complete containment for at least 300 yr and perhaps as long as 1000 yr, and they must be retrievable from the disposal site during the first 50 yr after emplacement. The containers will be exposed to high temperatures and high gamma radiation fields from the decay of high-level waste. This volume surveys the available data on the phase stability of both groups of candidate alloys. The austenitic alloys are reviewed in terms of the physical metallurgy of the iron-chromium-nickel system, martensite transformations, carbide formation, and intermetallic-phase precipitation. The copper-based alloys are reviewed in terms of their phase equilibria and the possibility of precipitation of the minor alloying constituents. For the austenitic materials, the ranking based on phase stability is: Alloy 825 (best), Type 316L stainless steel, and then Type 304L stainless steel (worst). For the copper-based materials, the ranking is: CDA 102 (oxygen-free copper) (best), and then both CDA 715 and CDA 613. 75 refs., 24 figs., 6 tabs.

19398 (UCID–21362-Vol.2) **Survey of degradation modes of candidate materials for high-level radioactive-waste disposal containers: Volume 2, Oxidation and corrosion.** Gdowski, G.E. (Science and Engineering Associates, Inc., Pleasanton, CA (USA)); Bullen, D.B. Lawrence Livermore National Lab., CA (USA). Aug 1988. 54p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-7405-ENG-48. Order Number DE90006358. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

Three copper-based alloys and three iron- to nickel-based austenitic alloys are being considered as possible materials for fabrication of containers for disposal of high-level radioactive waste. This waste will include spent fuel assemblies from reactors as well as high-level waste in borosilicate glass and will be sent to the prospective site at Yucca Mountain, Nevada, for disposal. The containers must maintain substantially complete containment for at least 300 yr and perhaps as long as 1000 yr. During the first 50 yr after emplacement, they must be retrievable from the disposal site. Shortly after the containers are emplaced in the repository, they will be exposed to high temperatures and high gamma radiation fields from the decay of the high-level waste. This volume surveys the available data on oxidation and corrosion of the iron- to nickel-based austenitic materials (Types 304L and 316L stainless steels and Alloy 825) and the copper-based alloy materials [CDA 102 (oxygen-free copper), CDA 613 (Cu-7Al), and CDA 715 (Cu-30Ni)], which are the present candidates for fabrication of the containers. Studies that provided a large amount of data are highlighted, and those areas in which little data exists are identified. Examples of successful applications of these materials are given. On the basis of resistance to oxidation and general corrosion, the austenitic materials are ranked as follows: Alloy 825 (best), Type 316L stainless steel, and then Type 304L stainless steel (worst). For the copper-based materials, the ranking is as follows: CDA 715 and CDA 613 (both best), and CDA 102 (worst). 110 refs., 30 figs., 13 tabs.

19399 (UCID–21362-Vol.3) **Survey of degradation modes of candidate materials for high-level radioactive-waste disposal containers: Volume 3, Localized corrosion and stress corrosion cracking of austenitic alloys.** Farmer, J.C. (Lawrence Livermore National Lab., CA (USA)); Van Konynenburg, R.A.; McCright, R.D.; Bullen, D.B. Lawrence Livermore National Lab., CA (USA). Apr 1988. 71p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-7405-ENG-48. Order Number DE90006359. Available from NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

Three iron- to nickel-based austenitic alloys (Types 304L and 316L stainless steels and Alloy 825) are being considered as candidate materials for the fabrication of high-level radioactive-waste containers. Waste will include fuel assemblies from reactors as well as high-level waste in borosilicate glass forms, and will be sent to the prospective repository at Yucca Mountain, Nevada. The decay of radionuclides in the repository will result in the generation of substantial heat and in fluences of gamma radiation. Container materials may undergo any of several modes of degradation in this environment, including atmospheric oxidation; uniform aqueous phase corrosion; pitting; crevice corrosion; sensitization and intergranular stress corrosion cracking (IGSCC); and transgranular stress corrosion cracking (TGSCC). This report is an analysis of data relevant to the pitting, crevice corrosion, and stress corrosion cracking (SCC) of the three austenitic candidate alloys. The candidates are compared in terms of their susceptibilities to these forms of corrosion. Although all three candidates have demonstrated pitting and crevice corrosion in chloride-containing environments, Alloy 825 has the greatest resistance to these types of localized corrosion (LC); such resistance is important because pits can penetrate the metal and serve as crack initiation sites. Both Types 304L and 316L stainless steels are susceptible to SCC in acidic chloride media. In contrast, SCC has not been documented in Alloy 825 under comparable conditions. Gamma radiation has been found to enhance SCC in Types 304 and 304L stainless steels, but it has no detectable effect on the resistance of Alloy 825 to SCC. Furthermore, while the effects of microbiologically induced corrosion have been observed for 300-series stainless steels, nickel-based alloys such as Alloy 825 seem to be immune to such problems. 211 refs., 49 figs., 10 tabs.

19400 (UCID–21362-Vol.4) **Survey of degradation modes of candidate materials for high-level radioactive-waste disposal containers: Volume 4, Stress corrosion cracking of copper-based alloys.** Farmer, J.C. (Lawrence Livermore National Lab., CA (USA)); Van Konynenburg, R.A.; McCright, R.D.; Gdowski, G.E. Lawrence Livermore National Lab., CA (USA). May 1988. 54p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-7405-ENG-48. Order Number DE90006360. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

Three copper-based alloys — CDA 102 (OFHC copper), CDA 613 (aluminum bronze), and CDA 715 (Cu-30Ni) — are being considered as possible materials for the fabrication of high-level

radioactive-waste disposal containers. Waste will include fuel assemblies from reactors as well as borosilicate glass forms, and will be sent to the prospective repository at Yucca Mountain, Nevada, for emplacement. The three copper-based alloys discussed here are being considered in addition to the iron- to nickel-based austenitic materials discussed in Volume 3. The decay of radionuclides will result in substantial heat generation and in fluxes of gamma radiation. In this environment, container materials may degrade by atmospheric oxidation, uniform aqueous phase corrosion, pitting, crevice corrosion, transgranular stress corrosion cracking (TGSCC) in tarnishing environments, or intergranular stress corrosion cracking (IGSCC) in nontarnishing environments. This report is a critical survey of available data on the stress corrosion cracking (SCC) of the three copper-based alloys. The requisite conditions for TGSCC and IGSCC include combinations of stress, oxygen, ammonia or nitrite, and water. Note that nitrite is generated by gamma radiolysis of moisture films in air but that ammonia is not. TGSCC has been observed in CDA 102 and CDA 613 exposed to moist ammonia-containing environments whereas SCC has not been documented for CDA 715 under similar conditions. SCC is also promoted in copper by nitrite ions. Furthermore, phosphorus-deoxidized copper is unusually susceptible to embrittlement in such environments. The presence of tin in CDA 613 prevents IGSCC. It is believed that tin segregates to grain boundaries, where it oxidizes very slowly, thereby inhibiting the oxidation of aluminum. 117 refs., 27 figs., 9 tabs.

19401 (UCID–21362-Vol.5) **Survey of degradation modes of candidate materials for high-level radioactive-waste disposal containers: Volume 5, Localized corrosion of copper-based alloys.** Farmer, J.C. (Lawrence Livermore National Lab., CA (USA)); Van Konynenburg, R.A.; McCright, R.D.; Gdowski, G.E. Lawrence Livermore National Lab., CA (USA). Jun 1988. 37p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-7405-ENG-48. Order Number DE90006361. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Three copper-based alloys, CDA 102 (oxygen-free, high-purity copper), CDA 613 (aluminum bronze), and CDA 715 (Cu-30Ni), are candidates for the fabrication of high-level radioactive-waste disposal containers. Waste will include spent fuel assemblies from reactors as well as borosilicate glass, and will be sent to the prospective repository site at Yucca Mountain in Nye County, Nevada. The decay of radionuclides will result in the generation of substantial heat and in fluxes of gamma radiation outside the containers. In this environment, container materials might degrade by atmospheric oxidation, general aqueous phase corrosion, localized corrosion (LC), and stress corrosion cracking (SCC). This volume is a critical survey of available data on pitting and crevice corrosion of the copper-based candidates. Pitting and crevice corrosion are two of the most common forms of LC of these materials. Data on the SCC of these alloys is surveyed in Volume 4. Pitting usually occurs in water that contains low concentrations of bicarbonate and chloride anions, such as water from Well J-13 at the Nevada Test Site. Consequently, this mode of degradation might occur in the repository environment. Though few quantitative data on LC were found, a tentative ranking based on pitting corrosion, local dealloying, crevice corrosion, and biofouling is presented. CDA 102 performs well in the categories of pitting corrosion, local dealloying, and biofouling, but susceptibility to crevice corrosion diminishes its attractiveness as a candidate. The cupronickel alloy, CDA 715, probably has the best overall resistance to such localized forms of attack. 123 refs., 11 figs., 3 tabs.

19402 (UCID–21362-Vol.6) **Survey of degradation modes of candidate materials for high-level radioactive-waste disposal containers: Volume 6, Effects of hydrogen in austenitic and copper-based alloys.** Gdowski, G.E. (Science and Engineering Associates, Inc., Pleasanton, CA (USA)); Bullen, D.B. Lawrence Livermore National Lab., CA (USA). Aug 1988. 39p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-7405-ENG-48. Order Number DE90006362. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Six alloys are being considered as possible materials for the fabrication of containers for the disposal of high-level radioactive waste. Three of these candidate materials are copper-based alloys: CDA 102 (oxygen-free copper), CDA 613 (Cu-7Al), and CDA 715 (Cu-30Ni). The other three are iron- to nickel-based austenitic materials: Types 304L and 316L stainless steels and Alloy 825. Radioactive waste will include spent-fuel assemblies from reactors as well as waste in borosilicate glass and will be sent to the prospective site at Yucca Mountain, Nevada, for disposal. The waste-package containers must maintain substantially complete containment for at least 300 yr and perhaps as long as 1000 yr. During the first 50 yr after emplacement, the containers must be retrievable from the disposal site. Shortly after emplacement of the containers in the repository, they will be exposed to high temperatures and high gamma radiation fields from the decay of high-level waste. This radiation will promote the radiolytic decomposition of moist air to hydrogen. This volume surveys the available data on the effects of hydrogen on the six candidate alloys for fabrication of the containers. For copper, the mechanism of hydrogen embrittlement is discussed, and the effects of hydrogen on the mechanical properties of the copper-based alloys are reviewed. The solubilities and diffusivities of hydrogen are documented for these alloys. For the austenitic materials, the degradation of mechanical properties by hydrogen is documented. The diffusivity and solubility of hydrogen in these alloys are also presented. For the copper-based alloys, the ranking according to resistance to detrimental effects of hydrogen is: CDA 715 (best) > CDA 613 > CDA 102 (worst). For the austenitic alloys, the ranking is: Type 316L stainless steel ≈ Alloy 825 > Type 304L stainless steel (worst). 87 refs., 19 figs., 8 tabs.

19403 (UCID–21362-Vol.7) **Survey of degradation modes of candidate materials for high-level radioactive-waste disposal containers: Volume 7, Weldability of austenitic alloys.** Strum, M.J. (Lawrence Livermore National Lab., CA (USA)); Weiss, H.; Farmer, J.C.; Bullen, D.B. Lawrence Livermore National Lab., CA (USA). Jun 1988. 49p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-7405-ENG-48. Order Number DE90006363. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

This volume surveys the effects of welding on the degradation modes of three austenitic alloys: Types 304L and 316L stainless steels and Alloy 825. These materials are candidates for the fabrication of containers for the long-term storage of high-level nuclear waste. The metallurgical characteristics of fusion welds are reviewed here and related to potential degradation modes of the containers. Three specific areas are discussed in depth: (1) decreased resistance to corrosion in the forms of preferential corrosion, sensitization, and susceptibility to stress corrosion cracking, (2) hot cracking in the heat-affected zone and the weld zone, and (3) formation of intermetallic phases. The austenitic alloys are ranked as follows in terms of overall weldability: Alloy 825 (best) > Type 316L stainless steel > Type 304L stainless steel (worst). 108 refs., 31 figs., 7 tabs.

19404 (UCID–21362-Vol.8) **Survey of degradation modes of candidate materials for high-level radioactive-waste disposal containers: Volume 8, Weldability of copper-based alloys.** Bullen, D.B. (Science and Engineering Associates, Inc., Pleasanton, CA (USA)); Gdowski, G.E.; Weiss, H. Lawrence Livermore National Lab., CA (USA). Jun 1988. 26p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-7405-ENG-48. Order Number DE90006364. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Three copper-based alloys, CDA 102 (oxygen-free copper), CDA 613 (Cu-7Al), and CDA 715 (Cu-30Ni), are being considered along with three austenitic candidates as possible materials for fabrication of containers for disposal of high-level radioactive waste. The waste will include spent fuel assemblies from reactors as well as high-level reprocessing wastes in borosilicate glass and will be sent to the prospective repository at Yucca Mountain, Nevada, for disposal. The containers must maintain mechanical integrity for 50 yr after emplacement to allow for retrieval of waste during the preclosure phase of repository operation. Containment is required to be substantially complete for up to 300 to 1000 yr. During the early period, the containers will be exposed to high temperatures and high gamma radiation fields from the decay of high-level waste. The final closure joint will be critical to the integrity of the containers. This volume surveys the available data on the metallurgy of

the copper-based candidate alloys and the welding techniques employed to join these materials. The focus of this volume is on the methods applicable to remote-handling procedures in a hot-cell environment with limited possibility of postweld heat treatment. The three copper-based candidates are ranked on the basis of the various closure techniques. On the basis of considerations regarding welding, the following ranking is proposed for the copper-based alloys: CDA 715 (best) > CDA 102 > CDA 613 (worst). 49 refs., 15 figs., 1 tab.

19405 (WHC-EP-0182-19) **Tank farm surveillance and waste status summary report for October 1989.** Thurman, J.M. Westinghouse Hanford Co., Richland, WA (USA). Feb 1990. 44p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. Order Number DE90006472. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report is Westinghouse Hanford Company's official inventory for high-level radioactive waste stored in underground tanks at the Hanford Site. Data that depict the status of stored, high-level waste and tank vessel integrity are contained within the report. The intent of the report is to provide data on each of the existing 177 underground waste tanks and provide supplemental information regarding tank anomalies and ongoing investigations.

19406 (WHC-EP-0229-Rev.1) **Double-shell tank waste disposal integration plan: Revision 1.** Augustine, C.A. Westinghouse Hanford Co., Richland, WA (USA). Jan 1989. 92p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. Order Number DE90006352. Available from NTIS, PC A05/MF A01 - OSTI.

In December 1987, the final environmental impact statement for Hanford Tank Wastes was issued by the US Department of Energy. The preferred alternative called for existing and future double-shell tank (DST) wastes to be pretreated, if necessary, in B Plant for separation of the waste into transuranic (TRU) waste, high-level waste (HLW), and low-level waste (LLW) fractions. The TRU waste and HLW fractions will be processed in the Hanford Waste Vitrification Plant (HWVP), which will solidify them into borosilicate waste glass for disposal in a geologic repository. The remaining LLW fraction will be processed into a cementitious grout and disposed of in near-surface concrete vaults. Implementation of disposal actions for DST wastes will require waste characterization and technology development for retrieval, pretreatment, and disposal processes, plus operation of the tanks, supporting systems and facilities, and B Plant, HWVP, and the Grout Treatment Facility. The Double-Shell Tank Waste Disposal Integration Plan defines the baseline processes, scope, schedule, and budget for implementation of DST waste disposal and defines the procedure changing the baseline. 113 refs., 100 figs., 26 tabs.

19407 (WHC-EP-0323) **Three applications of rule induction expert systems.** Zimmerman, B.D.; Jansen, G. Jr.; Moen, M.J. Westinghouse Hanford Co., Richland, WA (USA). Jan 1990. 39p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC06-87RL10930. Order Number DE90006374. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The purpose of this document is to illustrate the usefulness of expert systems created using a technique known as rule induction. The document is organized into four parts, including this introduction and three independent papers. The remainder of this introduction discusses expert systems in general and rule induction in particular; it is intended to introduce the concepts involved and to provide the background necessary to understand the technique. The three papers that follow illustrate the creation and use of rule induction expert systems in different domain areas. The papers (along with the introduction) are intended to demonstrate the ease with which expert systems can be constructed using rule induction, and to suggest the variety of analytical problems for which they may be of value. It is hoped that this document will serve to introduce a wider audience to the potential value and uses of rule-induction expert systems, and ultimately that it may stimulate more widespread use of such systems. 5 refs., 7 figs., 8 tabs.

19408 (WHC-SA-0678) **Heat removal options and temperature predictions for a vault of grouted waste.** Crea, B.A.; McCall, T.B. Westinghouse Hanford Co., Richland, WA (USA). Jan 1990. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. (CONF-900210-18: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90007617. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The US Department of Energy's Grout Disposal Program immobilizes low-level radioactive wastes that are stored in double-shell tanks on the Hanford Site. The wastes are mixed with cementitious materials to form a grout. The resulting slurry is then pumped into large underground vaults. Westinghouse Hanford Company developed a method to predict the transient temperature response of these vaults to the heat of hydration of the grout. This method was also used to investigate several options for removing some of the energy generated by the hydration reaction. The results of those analyses are presented here. 2 refs., 7 figs.

19409 (WHC-SA-0694) **Grout disposal system for Hanford site mixed waste.** Van Beek, J.E.; Wodrich, D.D. Westinghouse Hanford Co., Richland, WA (USA). Jan 1990. 12p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. (CONF-900210-8: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90007026. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Grout Treatment Facility has been constructed at Hanford for processing liquid radioactive and hazardous tank wastes into a cement-based solid for disposal in near-surface concrete vaults. A unique disposal system design has been developed to satisfy hazardous waste regulations and U.S. Department of Energy long-term performance criteria. This design will be used in the construction of 43 vaults for the disposal of 227,000 cubic meters of grouted mixed waste.

19410 (WHC-SA-0699) **Effects of varying recharge of radionuclide flux rates to the water table at a low-level solid waste burial site.** Khaleel, R.; LeGore, T. Westinghouse Hanford Co., Richland, WA (USA). Feb 1990. 16p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. (CONF-900210-14: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90007211. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Numerical simulations were conducted to model flow and transport from a low-level solid waste burial site at the Hanford Site in southeastern Washington. Solid waste burial trenches are located in the 200 Areas near the soil surface, above the water table. A heterogeneous, layered soil profile representative of the 200 Area soils was used in the simulations. Three recharge rates (0.05, 0.5, and 5.0 cm/yr) were considered. At the low recharge rate (0.05 cm/yr), diffusive transport in the horizontal direction was much larger than the computed flux to the water table. With an increase in the recharge rate, the computed flux rates to the water table were much higher than those computed for the right boundary. An increase in the recharge rate from 0.05 cm/yr resulted in the transformation of a diffusion-dominated problem into an advection-dominated one. 4 refs., 7 figs., 3 tabs.

19411 (WHC-SA-0700) **Characterization and remediation of past-practice waste units at the Hanford Site: An engineering perspective.** Carlson, R.A.; Johnson, W.L.; Lauterbach, M.J.; McCain, R.G. Westinghouse Hanford Co., Richland, WA (USA). Jan 1990. 11p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC06-87RL10930. (CONF-900210-21: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90007620. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Hanford Site contains 1,501 identified waste management units that are to be characterized and remediated and/or permitted over the next 30 years. The units include various types of liquid and solid waste disposal sites, underground tanks, and unplanned releases consisting of nonhazardous, hazardous, radioactive, and mixed wastes. To deal with this number of waste units, the Hanford Site has been subdivided into four aggregate areas, each of which is included on the US Environmental Protection Agency's National Priorities List. The collective aggregate areas have been further

subdivided into 78 operable units. A discussion of progress made to date on the first six operable units is provided in this report.

19412 (WHC-SA–0705) **RCRA closure experience with radioactive mixed waste 183 H Solar Evaporation Basins at the Hanford Site.** Powers, E.W.; Jackson, G.W. Westinghouse Hanford Co., Richland, WA (USA). Jan 1990. 13p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. (CONF-900210–15: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90007212. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper provides an overview of the Resource Conservation and Recovery Act of 1976 (RCRA) closure work of the 183-H Solar Evaporation Basins, at the Hanford Site for the Department of Energy-Richland Operations Office (DOE-RL), Richland, Washington. A detailed description of how the hazardous wastes and radioactive wastes (mixed wastes) were treated (i.e., sludge removal methods, liquid solidification process, and decontamination efforts) is provided. 7 refs., 5 figs.

19413 (WHC-SA–0738) **Hexone remediation demonstration.** Heine, W.F.; Rasmussen, O.R. Westinghouse Hanford Co., Richland, WA (USA). Jan 1990. 19p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. (CONF-900210–9: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90007027. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Hexone Remediation Demonstration is funded by the US Department of Energy Hazardous Waste Remedial Action Program to show complete remediation of an industrial-scale quantity of radioactively contaminated hazardous solvent waste. The specific material to be remediated consists of 34,000 gal of hexone (methyl isobutyl ketone), normal paraffin hydrocarbon, and tributyl phosphate complexes as well as 2,000 gal of solvent-saturated water. The solvents, utilized as extractants in nuclear fuel reprocessing plants at the Hanford Site, have been stored in two underground tanks for more than 20 years. The remediation approach is to separate the radioactive constituents, totaling approximately 0.25 Ci, from the waste by two-stage simple distillation and then incinerating the essentially nonradioactive distillate in a hazardous waste incinerator. The distillation operations will be carried out in sacrificial vessels — 300-gal-capacity steel tanks with heating coils — that will become the storage containers for the solid radioactive tar residues. The sacrificial distillation vessels will minimize the handling of radioactive tars and the radiation exposure to workers. The distilled condensate, with more than 99.9% of the original radioactivity removed, will be incinerated in a leased or purchased commercial hazardous waste incinerator modified to recover the remaining trace amounts of radionuclides from the offgas. The incinerator will be decontaminated or partially rebuilt for return to nonradioactive service. Clean closure of the waste tank site will be carried out by excavating the tanks, sandblasting the vessel interiors to remove transuranic rust and sludge, and finally by disposing of the tanks in a low-level radioactive waste burial ground. 4 figs., 1 tab.

19414 (WHC-SA–0796) **An overview of the vitrification of defense high-level waste at the Hanford Site.** Smith, R.A. (Westinghouse Hanford Co., Richland, WA (USA)); Nyman, D.H.; Wolfe, B.A.; Bromm, R.D. Westinghouse Hanford Co., Richland, WA (USA). Apr 1990. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. (CONF-900210–19: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90007618. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Nearly 63 percent of the nation's high-level nuclear waste has accumulated at the US Department of Energy's (DOE) Hanford Site in Washington State. This accumulation is due to defense materials production activities in the various processing facilities over the past 45 yr. The Hanford Waste Vitrification Plant (HWVP) is being developed to process the high-level waste fraction of the Hanford Site tank wastes into canisters of vitrified (borosilicate) glass. Storage of the filled canister will be provided for eventual shipment to a federal geologic repository. The Westinghouse Hanford Company (Westinghouse Hanford), a prime operating contractor for the DOE, has the lead responsibility for the successful completion and operation of the HWVP. Fluor Daniel, Inc. is the architect engineer with responsibility for facility and equipment specification and design. The general construction contractor is United Engineers and Constructors-Catalytic, Inc., which has the responsibility for all facility construction and equipment procurement. The Pacific Northwest Laboratory (PNL), operated by Battelle Memorial Institute for the DOE, is responsible for glass development technology. 2 refs., 3 figs.

19415 (WHC-SA–0808) **The long-term climate change assessmenet task of the protective barrier developoment program for low-level waste site remediation at the Hanford Site, Washington.** Petersen, K.L. Westinghouse Hanford Co., Richland, WA (USA). Jan 1990. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. (CONF-900406–22: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90006310. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A study plan is being developed to guide a multiyear program to assess long-term climate change and optimize the design of protective barriers. A protective barrier alternative is being considered for the disposal of some low-level radioactive defense waste stored near the surface at the Hanford Site, Washington. These barriers are being designed to limit movement of radionuclides and other contaminants to the accessible environment for at least 1000 years and possibly as long as 10,000 years. A stepwise approach to climatic data acquisition will be relied on in obtaining needed information for concurrent barrier tasks, and in developing a local climate forecast model. This model will need to couple past climate patterns with models of regional and global climate drivers to provide bounding conditions for barrier performance assessment analyses. 9 refs., 3 figs.

19416 (WHC-SA–0829) **Phosphate/Sulfate Waste grout campaign report.** Cline, M.W.; Tedeschi, A.R.; Yoakum, A.K. Westinghouse Hanford Co., Richland, WA (USA). Jan 1990. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. (CONF-900210–20: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90007619. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The grout facility, which is managed by Westinghouse Hanford Company for the Department of Energy, processed one million gal of low-level radioactive waste into a final-disposal form. The Phosphate/Sulfate Waste (PSW) campaign was initiated August 30, 1988, as part of Westinghouse Hanford Company's defense waste disposal program. The facility was restarted in April 1989 and again in June 1989 to complete processing 1,001,000 gal. Several deficiencies were identified during this campaign. The final operation of the facility in June 1989 successfully demonstrated the ability of both the Dry Materials Facility (DMF) and the Transportable Grout Equipment (TGE) facility to support conversion of low-level liquid wastes to grout slurry and subsequent transfer to a near-surface concrete value for solidification and disposal. 2 figs.

19417 (WHC-SA–0839) **Defense waste treatment and disposal activities at the Hanford Site.** McKenney, D.E.; Wodrich, D.D. Westinghouse Hanford Co., Richland, WA (USA). Jan 1990. 19p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. (CONF-900210–6: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90007024. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper presents an overview of defense waste treatment and disposal activities at the Hanford Site, a 1,500-square-kilometer federal facility in southcentral Washington State. Significant volumes of wastes, including radioactive, hazardous, and mixed wastes, have accumulated during the operating history of the Hanford Site. Present site operations also result in the generation of such wastes. Major waste categories at the Hanford Site include double-shell tank wastes, single-shell tank wastes, encapsulated

radiostrontium and radiocesium, stored solid wastes, and liquid effluents discharged to the soil column. Significant strides have been made towards providing regulatory-complaint storage, treatment, and disposal facilities for these major waste categories. Specific accomplishments include the completion of the first campaign to incorporate low-level liquids into a grout matrix for disposal, initiation of the single-shell tank waste characterization program, construction of a number of Hanford Central Waste Complex facilities, and initiation of design on the Hanford Waste Vitrification Plant. 1 ref., 7 figs.

0530 Environmental Aspects

Refer also to citation(s) 19326, 19328, 19331, 19333, 19335, 19338, 19339, 19341, 19342, 19343, 19348, 19356, 19357, 19360, 19365, 19366, 19367, 19374, 19376, 19379, 19380, 19382, 19385, 19387, 19390, 19391, 19393, 19394, 19395, 19405, 19409, 19412, 19415, 19417, 19427, 19428, 19429, 19430, 19431, 19432, 19433, 19434, 19435, 19439, 20069, 20081, 20382, 20456

19418 (DOE/ID–10087(88)) **Effluent Information System (EIS)/Onsite Discharge Information System (ODIS) 1988 executive summary.** Watanabe, T. EG and G Idaho, Inc., Idaho Falls, ID (USA). Nov 1989. 100p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (MISC–89152). Order Number DE90007020. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

The Effluent Information System (EIS) and Onsite Discharge Information System (ODIS) are Department of Energy (DOE) data base systems that aid DOE-Headquarters and Field Offices in managing the radioactive air and liquid effluents from DOE facilities. Data on effluents released offsite are entered into EIS and data on effluents discharged onsite and retained onsite are entered into ODIS. This document is a summary of information obtained from the CY 1988 effluent data received from all DOE and DOE contractor facilities and entered in the data based. Data from previous years are also included. The summary consists of two parts. The first part summarizes information for effluents released offsite, and the second part summarizes information for effluents retained onsite. These summaries are taken from the routine annual reports sent to each DOE Operations Office.

19419 (DOE/ID–12082-88) **The Idaho National Engineering Laboratory Site environmental report for calendar year 1988.** Hoff, D.L.; Mitchell, R.G.; Moore, R. Idaho National Engineering Lab., Idaho Falls, ID (USA). Jun 1989. 80p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90007240. Available from NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

This report describes the monitoring program, the collection of foodstuffs at the Idaho National Engineering Laboratory (INEL) boundary and distant offsite locations, and the collection of air and water samples at Site locations and offsite boundary and distant locations. The report also compares and evaluates the samples results, discussing implications, if any. Significant environmental activities at the INEL Site during 1988, nonradioactive and radioactive effluent monitoring at the Site, and the US Geological Survey (USGS) ground-water monitoring program are also summarized. 42 refs., 15 figs., 12 tabs.

19420 (RHO-BW-SA–291) **Radionuclide sorption and desorption reactions with interbed materials from the Columbia River basalt formation.** Barney, G.S. Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations. [1983]. 21p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC06-77RL01030. (CONF-830303–18: 185. American Chemical Society national meeting, Seattle, WA (USA), 20-25 Mar 1983). Available from OSTI; INIS.

The sorption and desorption behavior of radionuclides in groundwater-interbed systems of the Columbia River basalt formation was investigated. Radionuclides chosen for study were those of concern in assessing the safety of a high-level radioactive waste repository in basalt (isotopes of technetium, neptunium, plutonium, uranium, americium, cesium, strontium, and radium). Sandstone and tuff materials from selected interbed layers between basalt flows were used in these experiments. Effects of groundwater composition and redox potential (Eh) on radionuclide sorption and desorption on the geologic solids were studied. Sorption and desorption isotherms were obtained for sorption of radionuclides under oxidizing and reducing conditions. The Freundlich equation accurately describes most of these isotherms. 10 refs., 4 figs., 7 tabs.

0540 Health and Safety

Refer also to citation(s) 19348, 19358, 19386, 19406, 19415, 19567, 19572, 19738, 20063, 20368, 20456, 20464

19421 (CONF-900210–13) **Research and Development in support of the five-year plan.** Frank, C.W. (USDOE, Washington, DC (USA)); Craig, R.B.; Clark, L.W.; Middleman, L.I. Oak Ridge Gaseous Diffusion Plant, TN (USA). [1990]. 9p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. From 16. annual waste management symposium: working towards a cleaner environment; Tucson, AZ (USA); 25 Feb - 1 mar 1990. Order Number DE90007176. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

To support its 30-year cleanup goal and significantly reduce overall program cost, the Department of Energy (DOE) has committed to increase its investment in, and coordinate its management of, applied Research, Development, Demonstration, Testing, and Evaluation (RDDT&E) to resolve existing issues and rapidly advance beyond currently available waste management and waste site cleanup technologies. DOE has established a national applied RDDT&E program that will include involvement of DOE Operations Office, national laboratories, other Federal agencies, universities, and industry and that will seek the advice of external advisory and technical review groups. This paper describes a plan that clearly maps out a time-phased, needs-driven RDDT&E program to provide technologies over the next two decades for the safe, expeditious, and economical completion of DOE site environmental restoration and improved waste management operations.

19422 (DOE/EH–0125-Vol.1) **Environmental audit manual: Volume 1.** USDOE Assistant Secretary for Environment, Safety, and Health, Washington, DC (USA). Office of Environmental Audit. Jan 1990. 462p. Sponsored by U.S. DOE Environment Health & Safety. Order Number DE90006471. Available from NTIS, PC A20/MF A01 - OSTI.

The primary purpose of this manual is to provide a guide upon which an environmental regulatory compliance audit, assessment, or appraisal of a DOE facility can be conducted, and to ensure that all aspects of a particular regulatory area are adequately and consistently covered. In addition, this audit manual provides lines of inquiry to assess a facility's adherence to environmental best management practices (BMPs). The protocols are in a format such that the results and observations of an audit can be documented and recorded. The ultimate objectives of the use of this manual are to document a facility's compliance with environmental laws and regulations, identify areas of potential noncompliance, and plan for corrective action. Although this manual has been developed by a DOE Headquarters entity, it has been designed for use at all levels within DOE.

19423 (DOE/EH–0130) **Tiger Team Assessment of the Pantex Plant, Amarillo, Texas.** USDOE, Washington, DC (USA). Feb 1990. 852p. Sponsored by U.S. DOE Environment Health & Safety. Order Number DE90006344. Available from NTIS, PC A99/MF A01 - OSTI.

This document contains the findings and associated root causes identified during the Tiger Team Assessment of the Department of Energy's (DOE) Pantex Plant in Amarillo, Texas. This assessment was conducted by the Department's Office of Environment, Safety and Health between October 2 and 31, 1989. The scope of the assessment of the Pantex Plant covered all areas of environment, safety and health (ES&H) activities, including compliance with federal, state, and local regulations, requirements, permits, agreements, orders and consent decrees, and DOE ES&H Orders. The assessment also included an evaluation of the adequacy of DOE and site contractor ES&H management programs. The draft findings were submitted to the Office of Defense Programs, the

Albuquerque Operations Office, the Amarillo Area Office, and regulatory agencies at the conclusion of the on-site assessment activities for review and comment on technical accuracy. Final modifications and any other appropriate changes have been incorporated in the final report. The Tiger Team Assessment of the Pantex Plant is part of the larger Tiger Team Assessment program which will encompass over 100 DOE operating facilities. The assessment program is part of a 10-point initiative announced by Secretary of Energy James D. Watkins on June 27, 1989, to strengthen environmental protection and waste management activities in the Department. The results of the program will provide the Secretary with information on the compliance status of DOE facilities with regard to ES&H requirements, root causes for noncompliance, adequacy of DOE and site contractor ES&H management programs, and DOE-wide ES&H compliance trends.

19424 (DOE/ID–22083) **Evaluation of field sampling and preservation methods for strontium-90 in ground water at the Idaho National Engineering Laboratory, Idaho.** Cecil, L.D. (Geological Survey, Idaho Falls, ID (USA)); Knobel, L.L.; Wegner, S.J.; Moore, L.L. Geological Survey, Idaho Falls, ID (USA). Sep 1989. 24p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (USGS/WRIR–89-4146;MISC–89121). Order Number DE90006971. Available from NTIS, PC A03/MF A01; OSTI; INIS; USGS-OFR, U.S.G.S. Open File Service, Box 25425, Denver Federal Center, Denver, CO 80225; GPO Dep.

From 1952 to 1988, about 140 curies of strontium-90 have been discharged in liquid waste to disposal ponds and wells at the INEL (Idaho National Engineering Laboratory). The US Geological Survey routinely samples ground water from the Snake River Plain aquifer and from discontinuous perched-water zones for selected radionuclides, major and minor ions, and chemical and physical characteristics. Water samples for strontium-90 analyses collected in the field are unfiltered and preserved to an approximate 2-percent solution with reagent-grade hydrochloric acid. Water from four wells completed in the Snake River Plain aquifer was sampled as part of the US Geological Survey's quality-assurance program to evaluate the effect of filtration and preservation methods on strontium-90 concentrations in ground water at the INEL. The wells were selected for sampling on the basis of historical concentrations of strontium-90 in ground water. Water from each well was filtered through either a 0.45- or a 0.1-micrometer membrane filter; unfiltered samples also were collected. Two sets of filtered and two sets of unfiltered water samples were collected at each well. One set of water samples was preserved in the field to an approximate 2-percent solution with reagent-grade hydrochloric acid and the other set of samples was not acidified. 13 refs., 2 figs., 6 tabs.

19425 (DOE/OR/21548–065) **Baseline risk evaluation for exposure to bulk wastes at the Weldon Spring Quarry, Weldon Spring, Missouri.** Haroun, L.A.; Peterson, J.M.; MacDonell, M.M.; Hlohowskyj, I. Argonne National Lab., IL (USA). Jan 1990. 109p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-86OR21548;W-31109-ENG-38. Order Number DE90008103. Available from NTIS, PC A07/MF A01; OSTI; INIS; GPO Dep.

The US Department of Energy (DOE), under its Surplus Facilities Management Program (SFMP), is responsible for cleanup activities at the Weldon Spring site, Weldon Spring, Missouri. The site consists of a raffinate pits and chemical plant area and a quarry. This baseline risk evaluation has been prepared to support a proposed response action for management of contaminated bulk wastes in the quarry. The quarry became chemically and radioactively contaminated as a result of various wastes that were disposed of there between 1942 and 1969. This risk evaluation assesses potential impacts on human health and the environment that may result from exposure to releases of contaminants from the quarry under current site conditions. Risk assessment is a key component of the remedial investigation/feasibility study (RI/FS) process, as identified in guidance from the US Environmental Protection Agency (EPA); this process addresses sites subject to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986. Response actions at the Weldon Spring quarry are subject to CERCLA requirements because the quarry is listed on the EPA's National Priorities List. The DOE is also responsible for complying with the requirements of the National Environmental Policy Act (NEPA) of 1969, which requires federal agencies to consider the environmental consequences of a proposed action as part of the decision-making process for that action. Although this document has not been prepared to fulfill specific NEPA requirements, the analyses contained herein — along with the analyses provided in the remedial investigation, feasibility study, and other supporting documents — are intended to meet the environmental assessment requirements of NEPA.

19426 (DOE/OR/21548–109) **Assessment of Ash Pond Project effectiveness: Weldon Spring Site Remedial Action Project.** MK-Ferguson Co., St. Charles, MO (USA); Jacobs Engineering Group, Inc., St. Charles, MO (USA). Feb 1990. 44p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-86OR21548. Order Number DE90007225. Available from NTIS, PC A03/MF A01; OSTI; INIS.

In April 1989 the US Department of Energy (DOE) completed the Ash Pond Isolation Project at the Weldon Spring Site Remedial Action Project (WSSRAP). This Interim Response Action (IRA) was designed to reduce uranium concentrations in surface water released from the Ash Pond Outfall at the Weldon Spring Site (WSS). Uranium concentrations at this outfall have been measured as high as 5,500 pCi/l with an average concentration of 1,498 pCi/l. This project was one of several IRAs aimed at improving health and safety conditions at the WSS prior to the Record of Decision. The Ash Pond Isolation Project was constructed to intercept surface water runoff to the Ash Pond drainage and redirect flows around the Ash Pond and South Dump areas, thereby eliminating leaching and transport of uranium-contaminated materials from these source areas. The DOE has monitored the releases from the Ash Pond Outfall in fulfillment of the site's National Pollutant Discharge Elimination System Permit and initiated additional monitoring to further assess the effectiveness of the Ash Pond Isolation Project. Results of this monitoring effort indicate a reduction in uranium concentrations measured at the Ash Pond Outfall from a pre-completion average of 1,498 pCi/l to an average of 145 pCi/l following completion of the IRA. 6 refs., 6 figs., 3 tabs.

19427 (HW–12666-E) **Health Instrument divisions report for the month of February 1949: Progress report.** Parker, H.M. Hanford Works, Richland, WA (USA). 28 Feb 1949. 34p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC06-76RL01830. Order Number DE90007009. Available from NTIS, PC A03/MF A01 - OSTI.

Declassified 17 Nov 1989.

Four Class I special hazards incidents were reported. In none of these was there serious exposure of personnel. In the Operational Division, increased canyon maintenance work placed a heavy monitoring load on the survey group. Hazardous conditions in some instances were aggravated by apparent haste in various phases of maintenance and operations. In the Control and Development Division, analytical results on samples of water, air, and vegetation followed the normal pattern. Special tests were continued on the bioassay procedure for plutonium analyses to determine and eliminate the troublesome low yield problem. Work in establishing the Biology Division botany experimental farm progressed satisfactorily. Electrostatic precipitators were installed and collection of active particles began.

19428 (HW–12937-E) **Health Instrument Divisions report for month of March 1949.** Parker, H.M. Hanford Works, Richland, WA (USA). 31 Mar 1949. 31p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC06-76RL01830. Order Number DE90007008. Available from NTIS, PC A03/MF A01 - OSTI.

Declassified 17 Nov 1989.

Three Class I special hazards incidents were reported; one indicated how errors or relaxation in control can cause spread of dangerous amounts of active materials through public residences, vehicles, etc. Several hazardous conditions operating errors, or improper personal contamination surveys, were reported by the Operational Division. Normal results were obtained on samples of water, air, and vegetation. The low yield problem in the bioassay procedure for plutonium analysis was reported solved.

19429 (HW–13190-E) **Health instrument divisions report for month of April 1949: Progress report.** Parker, H.M. Hanford Works, Richland, WA (USA). 2 May 1949. 33p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC06-76RL01830. Order Number DE90007007. Available from NTIS, PC A03/MF A01 - OSTI.

Declassified 16 Nov 1989.

Two Special Hazards Incidents were reported. Contamination of expensive equipment that otherwise could have been offered for sale occurred in one. The first case of plutonium was reported. The occurrence of plutonium contamination in the air in buildings reflects the risk that hazards in such locations may exceed those in the primary plutonium-handling facilities.

19430 (HW–13561-E) **Health Instrument Division's report for month of May 1949.** Parker, H.M. Hanford Works, Richland, WA (USA). 31 May 1949. 26p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC06-76RL01830. Order Number DE90007006. Available from NTIS, PC A03/MF A01 - OSTI.

Declassified 28 Nov 1989.

There was one Special Hazards Incident investigated without serious consequence. Health Instrument Operational Division findings and control results were generally normal. Weak points in protection were observed in the P-10 operation, and in contamination control in the canyon buildings. Speculations are reported on the reason for anomalous decay rate of mixed polonium-boron sources.

19431 (HW–13793-E) **Health instrument divisions report for month of June 1949: Progress report.** Parker, H.M. General Electric Co., Richland, WA (USA). Hanford Atomic Products Operation. 30 Jun 1949. 22p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC06-76RL01830. Order Number DE90007005. Available from NTIS, PC A03/MF A01 - OSTI.

28 Nov 1989.

Three Class 1 special incidents were investigated. They covered using improper equipment in sampling, removal of contaminated material contrary to special work permit specifications, and handling of unduly active material with the gloved hand. (KD)

19432 (HW–14043-E) **Health instrument divisions report for month of July 1949: Progress report.** Parker, H.M. General Electric Co., Richland, WA (USA). Hanford Atomic Products Operation. 31 Jul 1949. 24p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC06-76RL01830. Order Number DE90007004. Available from NTIS, PC A03/MF A01 - OSTI.

Declassified 8 Jan 1990.

There were five Special Hazards Incidents investigated, all without serious consequences. Health Instrument Operational and Development Division findings, in general, were normal. Biology Division control monitoring showed no exceptional result.

19433 (HW–21260-E) **Health instrument Divisions report for month of May 1951.** Parker, H.M. Hanford Works, Richland, WA (USA). 4 Jun 1951. 30p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC06-76RL01830. Order Number DE90007033. Available from NTIS, PC A03/MF A01 - OSTI.

Declassified 6 Feb 1990.

There was an unusual density of special hazards incidents, with seven informal and six formal Class I investigations. Extensive contamination of a Richland residence occurred for the first time, and received much attention in the local and national press. Surveys by the Operational Division showed no significant deviation from expected findings, except in the matter of tritium concentrations in the atmosphere. Concentration of radioiodine in the atmosphere exceeded appropriate limits for extended operation.

19434 (HW–21506-E) **Health instrument divisions report for month of June 1951: Progress report.** Parker, H.M. General Electric Co., Richland, WA (USA). Hanford Atomic Products Operation. 2 Jul 1951. 29p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC06-76RL01830. Order Number DE90007032. Available from NTIS, PC A03/MF A01 - OSTI.

Declassified 2 Feb 1990.

There were eight informal special hazards incident investigation. One overexposure resulted from accumulation of I^{131} in the thyroid gland. The emission of I^{131} from the separations plants exceeded desirable levels. Vegetation contamination by I^{131} over a wide area reached levels higher than those which should properly be maintained in a public area.

19435 (HW–21802-E) **Health instrument Divisions report for month of July 1951.** Parker, H.M. Hanford Works, Richland, WA (USA). 6 Aug 1951. 30p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC06-76RL01830. Order Number DE90007031. Available from NTIS, PC A03/MF A01 - OSTI.

Declassified 6 Feb 1990.

There were five informal and two Class I special hazards incident investigations. The continued emission of I^{131} from the separations plants contaminated vegetation to excessive levels over an area in excess of 20,000 square miles. Corrective measures applied in mid-month were expected to restore this type of contamination to normal levels. Some peculiar results in the measurement of active particle concentrations in the atmosphere of the states of Washington, Oregon, Idaho and (western) Montana were suggestive of contributions from extraneous sources. In biological research, an incredible rate of conversion of hydrogen to water by organisms, not classically recognized as hydrogen users, was detected by tritium tracer methods.

19436 (OEFZS–4499) **The OENORM S 5200 'Radioactivity in building materials' as a tool for radiation protection of the general population.** Kunsch, B. (Oesterreichisches Forschungszentrum Seibersdorf G.m.b.H. (Austria). Inst. fuer Physik); Steger, F.; Tschirf, E. Oesterreichisches Forschungszentrum Seibersdorf G.m.b.H. (Austria). Apr 1989. 9p. (PH–468/89;ST–165/89). Order Number DE90617643. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

This report comprises two papers, one which is announced in the title, i.e. B. Kunsch, F. Steger, E. Tschirf: The OENORM S 5200 'Radioactivity in building materials' as a tool for radiation protection of the general population; and in addition a paper by F. Steger, H. Stadtmann, P. Kindl, L. Breitenhuber: Radon in dwellings: investigations and measurements. The two papers are treated separately. (qui).

19437 (OEFZS-A–1444) **Radiation protection control report for the research centre Seibersdorf for the year 1988: Results of all measurements which have been performed to protect the employees and the environment of the Research Centre Seibersdorf.** Mueck, K. (Oesterreichisches Forschungszentrum Seibersdorf G.m.b.H. (Austria). Inst. fuer Strahlenschutz); Steger, F.; Hefner, A. Oesterreichisches Forschungszentrum Seibersdorf G.m.b.H. (Austria). May 1989. 75p. (In German). (ST–167/89). Available from the Austrian Research Centre Seibersdorf, A-2444 Seibersdorf (Austria). Available from the Austrian Research Centre Seibersdorf, A-2444 Seibersdorf (Austria).

Limited Distribution.

The radiation protection control report for the Research Centre Seibersdorf comprises the results of all measurements which have been performed during the year 1988 by the radiation protection control department to protect the employees and the environment of the Research Centre Seibersdorf. Personnel monitoring was carried out by TL-dosimetry to control the external dose, by body counting and excretion analysis for the surveillance of internal exposure. Monitoring of working places was performed by smear tests and measurements of the activity concentration in the air. The result of the environmental surveillance proves that in the year of 1988 no employee of the centre or any other firms was exposured to a dose above the limits set in the Austrian code of regulations. The net dose, amounted to less than 1% of the annual limit of 50 mSv for occupationally exposed workers. For a collective of 345 employees actually occupied in radiation areas the average annual dose amounted to 1,47 mSv/a (147 mrem/a) which is less than 3 % of the maximum value. The releases to the environment were also below the limits set by the authorities, is many cases by orders of magnitude. In accordance with this, the measurements in the environment of the research centre prove that no influence of the research centre on the environment is observable. 23 tabs., 14 figs. (Author, shortned by qui).

19438 (PNL–7251) **Level 1 remedial investigation work plan, 300 Area Process Ponds.** Pacific Northwest Lab., Richland, WA (USA); ICF Northwest, Richland, WA (USA). Jun 1987. 87p. Sponsored by U.S. DOE Energy Research. DOE Contract AC06-76RL01830. Order Number DE90007100. Available from NTIS, PC A05/MF A01 - OSTI.

This report discusses the objectives of the site characterization for the 300 Area Process Ponds which are to identify and quantify contamination at the ponds and to estimate their potential impact on human health and the environment. The results of the site characterization will be used to identify any future actions related to contamination at the site and to identify any additional data requirements needed to support selection of a remedial action. 9 refs., 12 figs., 8 tabs.

19439 (PNL–7252) **Draft Level 1 Remedial Investigation Work Plan: 316-3 waste disposal trenches.** ICF Northwest, Richland, WA (USA). Sep 1987. 114p. Sponsored by U.S. DOE Energy Research. DOE Contract AC06-76RL01830. Order Number DE90007102. Available from NTIS, PC A06/MF A01; OSTI; INIS.

This work plan describes the work to be performed for the initial level of site characterization for the 316.3 Trenches at the Hanford Site. This initial site characterization effort will include a review of existing environmental contamination data for the 300 Area as well as collection and analysis of environmental samples to better characterize subsurface contamination at the site. 7 refs., 10 figs., 7 tabs.

19440 (WHC-SA–0631) **Decommissioning of surplus facilities at the Hanford Site.** Goodenough, J.D. (USDOE Richland Operations Office, WA (USA)); Hughes, M.C.; Jackson, G.W. Westinghouse Hanford Co., Richland, WA (USA). Jan 1990. 13p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. (CONF-900210–7: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90007025. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In 1943, as part of the war effort, the US Army Corps of Engineers selected the Hanford Site as the area to construct the first full-scale plutonium production facilities. Between 1943 and 1955, eight production reactors were built at the Hanford Site, along with numerous support facilities including major facilities used for the fuels separation process. Currently, over 100 of these facilities at the Hanford Site have been declared surplus and are to be decommissioned. This includes eight shutdown production reactors located in the 100 Area and two large fuels separation/process facilities located in the 200 Area. Other than the ongoing required surveillance and maintenance work, there are three significant decommissioning project activities currently under way: the decommissioning of the Strontium Semiworks Pilot Fuel Reprocessing Plant, the closure/cleanup of the 183-H Solar Evaporation Basins, and the planning for decommissioning of the eight surplus production reactors. 5 refs., 7 figs., 1 tab.

19441 (WSRC-RP–89-1080) **Overview of decontamination technology.** Rankin, W.N.; McGlynn, J.F. Westinghouse Savannah River Co., Aiken, SC (USA). [1990]. 17p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. (CONF-900132–2: Workshop on decontamination and decommissioning of nuclear facilities, Las Vegas, NV (USA), 22-25 Jan 1990). Order Number DE90007118. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper consists of an overview of the decontamination technology program being carried out at the Savannah River Site and discusses the use of state-of-the-art equipment and techniques for decontamination and removal applications. The purpose of the program is to minimize personnel radiation exposure, minimize the potential for uptake of radioactive material, and reduce the volume of contaminated waste. Implementation of technology and the status of new applications are discussed. 6 refs., 42 figs.

0550 Safeguards, Inspection, and Accountability

Refer also to citation(s) 19441, 19447

19442 (IAEA-INFCIRC–225(Rev.2)) **The physical protection of nuclear material.** International Atomic Energy Agency, Vienna (Austria). Dec 1989. 24p. Order Number DE90617968. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A Technical Committee on Physical Protection of Nuclear Material met in April-May 1989 to advise on the need to update the recommendations contained in document INFCIRC/225/Rev.1 and on any changes considered to be necessary. The Technical Committee indicated a number of such changes, reflecting mainly: the international consensus established in respect of the Convention on the Physical Protection of Nuclear Material; the experience gained since 1977; and a wish to give equal treatment to protection against the theft of nuclear material and protection against the sabotage of nuclear facilities. The recommendations presented in this IAEA document reflect a broad consensus among Member States on the requirements which should be met by systems for the physical protection of nuclear materials and facilities. 1 tab.

19443 (K/ITP–238) **Nuclear material safeguards during storage and disposal of spent nuclear fuel.** Moran, B.W. Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA). Dec 1988. 7p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OT21400. (CONF-890126–1: INMM spent fuel management seminar, Washington, DC (USA), 11-13 Jan 1989). Order Number DE90007111. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The systems and facilities of the US federal waste management system (FWMS) – managed by the US Department of Energy's (DOE's) Office of Civilian Radioactive Waste Management – will be subject to the requirements of nuclear materials safeguards. The FWMS will handle both spent nuclear fuel (SNF) and high-level radioactive waste (HLW). For SNF, the FWMS will include acceptance at the power reactor, transportation to the FWMS facilities, conditioning for storage and disposal, monitored retrievable storage (MRS), and disposal in a mined geologic repository. The safeguards requirements that must be considered and planned for early in the design of the FWMS systems and facilities are those specified in, under development for inclusion in, the DOE orders and US Nuclear Regulatory Commission (NRC) regulations and those being developed by the International Atomic Energy Agency (IAEA). Early identification of technical and institutional issues can prevent possible delays in the licensing of the FWMS facilities and ensure more economical implementation of the required safeguards elements in the FWMS. 2 refs.

19444 (LA-UR–89-4151) **International safeguards relevant to geologic disposal of high-level wastes and spent fuels.** Pillay, K.K.S.; Picard, R.R. Los Alamos National Lab., NM (USA). [1989]. 12p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-900406–7: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90004843. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Spent fuels from once-through fuel cycles placed in underground repositories have the potential to become attractive targets for diversion and/or theft because of their valuable material content and decreasing radioactivity. The first geologic repository in the US, as currently designed, will contain approximately 500 Mt of plutonium, 60,000 Mt of uranium and a host of other fissile and strategically important elements. This paper identifies some of the international safeguards issues relevant to the various proposed scenarios for disposing of the spent fuel. In the context of the US program for geologic disposal of spent fuels, this paper highlights several issues that should be addressed in the near term by US industries, the Department of Energy, and the Nuclear Regulatory Commission before the geologic repositories for spent fuels become a reality. Based on US spent fuel discharges, an example is presented to illustrate the enormity of the problem of verifying spent fuel inventories. The geologic disposal scenario for high-level wastes originating from defense facilities produced a "practicably irrecoverable" waste form. Therefore, safeguards issues for geologic disposal of high-level waste now in the US are less pressing. 56 refs. , 2 figs.

0560 Legislation and Regulations

Refer also to citation(s) 19324, 19335, 19352, 19421, 19423, 19557, 19572, 19791, 20464

19445 (IAEA-INFCIRC–97(Add.1)) **Agreement of 9 December 1988 between the International Atomic Energy Agency and the Government of the Islamic Republic of Iran amending the project agreement between the Agency and the Government of Iran establishing a research reactor project.** International Atomic Energy Agency, Vienna (Austria). Jan 1990. 5p. Order Number DE90617972. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The document reproduces the text of the agreement of 9 December 1988 between the Government of the Islamic Republic of Iran and the Agency amending the project agreement of 10 May 1967 between the Agency and the Government of Iran for assistance by the Agency to Iran in establishing a five megawatt pool-type research reactor at the Teheran Nuclear Centre of the University of Teheran.

19446 (IAEA-INFCIRC–97(Add.2)) **Additional supply agreement of 9 December 1988 between the International Atomic Energy Agency and the Governments of the Islamic Republic of Iran and of Argentina for the transfer of enriched uranium for a research reactor in Iran.** International Atomic Energy Agency, Vienna (Austria). Jan 1990. 4p. Order Number DE90617961. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Hard copies are available in English and Spanish from IAEA Division of Publications, Distribution Unit.

The document reproduces the text of the additional supply agreement of 9 December 1988 between the IAEA and the Government of the Islamic Republic of Iran and of Argentina for the transfer of 115.80 kilograms of uranium enriched up to 20% in the isotope uranium-235 for a research reactor in Iran.

19447 (IAEA-INFCIRC–371) **Agreement of 24 October 1989 between the Kingdom of Bhutan and the International Atomic Energy Agency for the application of safeguards in connection with the treaty on the non-proliferation of nuclear weapons.** International Atomic Energy Agency, Vienna (Austria). Jan 1990. 35p. Order Number DE90617969. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The document contains two parts. The first part stipulates the agreement of Bhutan to accept safeguards on all source or special fissionable material in all peaceful nuclear activities within its territory, under its jurisdiction or carried out under its control anywhere, for the exclusive purpose of verifying that such material is not diverted to nuclear weapons or other nuclear explosive devices. The second part specifies the procedures to be applied in the implementation of the safeguards provisions of Part I.

19448 (IAEA-INFCIRC–372) **Letter to the Director General from representatives of the Depository Powers for the treaty on the non-proliferation of nuclear weapons.** International Atomic Energy Agency, Vienna (Austria). Dec 1989. 1p. Order Number DE90617970. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The document reproduces a letter (dated 12 December 1989) to the Director General of the IAEA from representatives of the Depository Powers for the Treaty on the Non-Proliferation of Nuclear Weapons as a result of their discussions on 11 and 12 December with representatives of the Republic of South Africa concerning its accession to the Treaty and related matters.

19449 (IAEA-INFCIRC–373) **Statement by the Iraqi Ministry of Foreign Affairs on the twentieth anniversary of Iraq's ratification of the treaty on the non-proliferation of nuclear weapons (NPT).** International Atomic Energy Agency, Vienna (Austria). Jan 1990. 2p. Order Number DE90617971. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Hard copies are available in Arabic and English from IAEA Division of Publications, Distribution Unit.

The document reproduces the full text of the statement made by the Iraqi Ministry of Foreign Affairs on the twentieth anniversary of Iraq's ratification of the Treaty on the Non-Proliferation of Nuclear Weapons.

19450 (WHC-SA–0709) **Implementation of the Hanford Federal Facility Agreement and Consent Order.** Izatt, R.D. (USDOE, Washington, DC (USA)); McGuire, H.E.; Waite, J.L.; Morrison, R.D. Westinghouse Hanford Co., Richland, WA (USA). Feb 1990. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. (CONF-900210–17: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90007616. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Hanford Federal Facility Agreement and Consent Order represents a comprehensive effort to clean up the Hanford Site and bring it into compliance with the Resource Conservation and Recovery Act and the Comprehensive Environmental Response, Compensation and Liability Act. The Tri-Party Agreement has been a success story since it was signed on May 15, 1989. All milestones have been completed on schedule, the public has been and continues to be involved, and the regulatory agencies have been working together in support of the agreement. But the future includes many challenges and problems that the three parties must resolve in a cooperative fashion to assure a safe and effective cleanup at the Hanford Site. 3 refs., 4 figs.

07 ISOTOPE AND RADIATION SOURCE TECHNOLOGY

0701 Physical Isotope Separation

Refer also to citation(s) 20192

19451 (PSI–48) **Development of an ECR ion source for the mass separation of xenon radioisotopes.** Hofer, M. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)). Paul Scherrer Inst. (PSI), Wuerenlingen (Switzerland). Oct 1989. 179p. (In German). Order Number DE90614726. Available from NTIS (US Sales Only), PC A09/MF A01 - OSTI; INIS.

ECR (Electron Cyclotron Resonance).

The electron cyclotron resonance (ECR) principle has been studied for mass separation applications. Features of ECR ion sources make them ideally suited for online mass separation. A single stage 6.4 GHz test source for the separation of $^{123}Xe/^{125}Xe$ was built at the Paul Scherrer Institute (PSI). This report describes design, construction and testing of the source. Use was made of basic design ideas of the experimentally successful Karlsruhe source of Bechtold and Sheikh. Due to their fundamental simplicity, almost all single stage sources show the same main features: a set of Helmholtz-coils to induce the axial magnetic field, radial microwave injection, a Sm_2Co_{17}-hexapole inside a multimode cavity, two concentric quartz tubes as vacuum and plasma volumes. The source development took place at a Scandinavian type mass separator equipped with a 55°-double focusing magnet. About 1200 h of operation were accumulated and data was collected reliably. A screening design was used to identify the most important parameters. The effect of these parameters was investigated qualitatively as well as quantitatively and optimal ranges for source pressure, microwave power and axial magnetic field were determined. Under these operating conditions, an efficiency of 57% was achieved for singly charged Xe with H_2 as support gas. Optimal parameter ranges were verified running various tracer and support gases. H_2 turned out to be the most efficient support gas, but due to cluster formation, Helium should be used for the separation of neighbour masses (M/z) and ((M+1)/z). In runs with radioactive ^{127}Xe, a total efficiency of 40% was determined under non-optimal conditions. These trials showed clearly the difficulties associated with batch-separation of radioisotopes which especially occur when handling very small amounts of material. (author) 32 figs., 16 tabs., 65 refs.

0702 Radiation Sources

Refer also to citation(s) 20014, 20021, 20022, 20026, 20027, 20030, 20034, 20038

19452 (OEFZS–4484) **Holdup time measurement by radioactive tracers in pulp production.** Roetzer, H. (Oesterreichisches Forschungszentrum Seibersdorf G.m.b.H. (Austria). Inst. fuer Isotopenanwendung); Donhoffer, D. Oesterreichisches Forschungszentrum Seibersdorf G.m.b.H. (Austria). Dec 1988. 18p. (In German). (IA–169/88). Order Number DE90617792. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A batch of pulp was to be labelled before passing two bleaching towers of a pulp plant. Activated glass fibres were used as a tracer, which contained 24-Na with a half-life of 15 hours. It was shown in laboratory tests, that the glass fibres were suitable for transport studies of wood pulp. For use in the tests the fibres were activated and suspended in water. Due to the small diameter of the fibres (2-5 micrometers) this suspension shows physical properties very similar to the pulp. For detection six scintillation probes were mounted at different positions outside the bleaching tower. Radiation protection during the test was very easy due to the low total activity of the tracer material. Residence time distributions for both towers were measured. The successful tracer experiments show, that the method of labelling is suited for investigations of material transport in the pulp and paper industry. 3 figs., 11 refs., 2 tabs. (Author).

19453 (PPA-A–79) **Formulation of eb-curable epoxy resin : some important parameters.** Dahlan bin Haji Mohd (Unit Tenaga Nuklear, Bangi, Selangor (Malaysia)); Hosoi, Fumio; Sasaki, Takashi. Unit Tenaga Nuklear, Bangi, Selangor (Malaysia). [1989]. 28p. Order Number DE90617787. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The works on the electron-beam curing of surface coatings using epoxy acrylic-based resins were discussed. The works covered among other things the effect of molecular weights of the resins on the physical properties of coatings and their physical and chemical characterizations. The emphasis was given to formulating the resins applicable to surface coatings. Curings were done on a low-energy electron beam accelerator operating at 250 kV. A number of parameters deemed important to formulations, such as the molecular weights of the oligomers and monomers, monomer ratios, and HEA additions were explored. It was found that one could modify the physical properties of the coatings by changing or adjusting those parameters. (author).

0703 Isotopic Power Supplies

Refer also to citation(s) 19777, 19778, 19780, 19784, 19785, 19786

19454 (MLM–3624-OP) **Safety analysis for the Galileo Light-Weight Radioisotope Heater Unit.** Johnson, E.W. EG and G Mound Applied Technologies, Miamisburg, OH (USA). [1990]. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-88DP43495. (CONF-900109–21: 7. symposium on space nuclear power systems, Albuquerque, NM (USA), 7-11 Jan 1990). Order Number DE90007147. Available from NTIS, PC A02/MF A01 - OSTI.

The Light-Weight Radioisotope Heater Unit (LWRHU) will be used on the NASA Galileo Mission to provide thermal energy to the various systems on the orbiter and probe that are adversely affected by the low temperature a spacecraft encounters during a long interplanetary mission. Using these plutonia-fueled sources in 1-W increments permits employment of a single design and provides the spacecraft user the option of how many to use and where to position them to satisfy the proper thermal environment for components requiring such consideration. The use of the radioisotope ^{238}Pu in these devices necessitates the assessment of postulated radiological risks which might be experienced in case of accidents or malfunctions of the space shuttle or the spacecraft during phases of the mission in the vicinity of the earth. Included are data for the design, mission descriptions, postulated accidents with their consequences, test data, and the derived source terms and personnel exposures for the various events. 4 refs., 4 figs., 1 tab.

08 HYDROGEN

0801 Production

Refer also to citation(s) 19745

19455 (AIST–8905-1) **Japan's Sunshine Project. 1988 Annual summary of hydrogen energy R and D.** Agency of Industrial Science and Technology, Tokyo (Japan). Apr 1989. 62p. (In Japanese). Order Number DE90753043. Available from NTIS (US Sales Only), PC A04/MF A01.

An outline of 1988 annual summary of hydrogen energy R and D was described. As for the study on production of hydrogen; research on the basic technology for water electrolysis using solid polymer electrolytes was conducted. In the case of use of fluororesin cation-exchange membranes as an H? ion conductor, damage of membrane-electrocatalyst composites was reduced by improvement of current collectors. Anion-exchange membranes of OH^- ions conducting type, which are excellent in stability and operating costs, have been studying. ZrO_2-Y_2O_3 electrolyte for high temperature water vapor electrolysis was also studied. As for transportation and storage of hydrogen; new hydrides with high packing density was developed, technology for characterizing metal hydrides and molding/processing techniques were investigated. Effective systems for storage of hydrogen and its conversion into electric power by using hydrogen storage alloys as a reversible hydrogen storage electrods, have been developing. The study of microencapsulation for heightening charge-discharge performances was also conducted. Fundamental study on hydrogen-fueled engine with inert gas recirculation system was carried out. Hydrogen environment embrittlement of welding parts of materials and its prevention measures were examined. 29 figs., 2 tabs.

19456 (AIST–8905-2) **Japan's Sunshine Project. 1988 Annual summary of hydrogen energy R and D.** Agency of Industrial Science and Technology, Tokyo (Japan). Apr 1989. 56p. Order Number DE90753044. Available from NTIS (US Sales Only), PC A04/MF A01.

An outline of 1988 annual summary of hydrogen energy R and D was described. As for the study on production of hydrogen; research on the basic technology for water electrolysis using solid polymer electrolytes was conducted. In the case of use of fluororesin cation-exchange membranes as an H? ion conductor, damage of membrane-electrocatalyst composites was reduced by improvement of current collectors. Anion-exchange membranes of OH^- ions conducting type, which are excellent in stability and operating costs, have been studying. ZrO_2-Y_2O_3 electrolyte for high temperature water vapor electrolysis was also studied. As for transportation and storage of hydrogen; new hydrides with high packing density was developed, technology for characterizing metal hydrides and molding/processing techniques were investigated. Effective systems for storage of hydrogen and its conversion into electric power by using hydrogen storage alloys as a reversible hydrogen storage electrode, have been developing. The study of microencapsulation for heightening charge-discharge performances was also conducted. Fundamental study on hydrogen-fueled engine with inert gas recirculation system was carried out. Hydrogen environment embrittlement of welding parts of materials and its prevention measures were examined. 29 figs., 3 tabs.

19457 (BNL–43428) **IEA implementing agreement for a programme of research and development on the production of hydrogen from water: Task 9, Hydrogen production: Technical report 1988.** Mezzina, A. (ed.) (Brookhaven National Lab., Upton, NY (USA)); Struck, B.D. (ed.). Brookhaven National Lab., Upton, NY (USA). Jan 1989. 109p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-76CH00016. Order Number DE90007354. Available from NTIS, PC A06/MF A01 - OSTI.

Research programs on hydrogen production from USA, Canada, Japan, and the Federal Republic of Germany, are described. The programs are in the areas of electrolyte hydrogen production, thermochemical hydrogen production, and photocatalytic hydrogen production. (CBS)

0802 Storage, Transport, and Handling

Refer also to citation(s) 19455, 19456

0805 Health and Safety

Refer also to citation(s) 19455, 19456

09 BIOMASS FUELS

19458 (IE-MOEI–88/0102 vp) **An overview of renewable energy activities in Sri Lanka.** Sepalage, B.P. (Ceylon Electricity Board, Alternative Energy Development, (Sri Lanka)). Ministry of Energy and Infrastructure, Jerusalem (Israel). 12 Jun 1988. (CONF-8806247–: International workshop on renewable energy in developing countries, Kiryat Anavim (Israel), 12-17 Jun 1988). In *Renewable energy in developing countries. An international workshop.* Available from COSTI P.O.B 20125, TEL-AVIV 61201.

Order with complete bibliographic information.

Sri Lanka has a predominantly agricultural economy and about 80% of its energy comes from firewood, about 20% from oil, with small amounts of electricity and coal. A number of organizations operate under the Ministry of Power and Energy to promote a variety of planning, research and operational activities relevant to renewable energy. Active programs in solar energy include: data base development, water heater development, photovoltaic system development, and solar stills, cookers and crop dryers. Wind energy programs include: water pumping, milling, resource assessment and small-scale electricity generation. Biogas and biomass programs include a number of demonstration and popularization programs, village electrification, development and promotion of improved wood-burning stoves, development of wood and charcoal gasifiers, and exploitation of agricultural wastes. Small hydro power programs include the development of power generation turbines, the development of small plants for tea factories and training of personnel. (RP) 1 tab.

0907 Resources

Refer also to citation(s) 19469

0908 Production

Refer also to citation(s) 19469, 19482

19459 (AD-A–214111/7/XAB) **Production and analysis of the biopolymer chitosan from Mucor rouxii. Final report, December 1985-July 1987.** Arcidiacono, S.; Kaplan, D.L. Army Natick Research and Development Center, MA (USA). Nov 1987. 49p. (NATICK/TR–88/046). Available from NTIS, PC A03/MF A01.

To determine the potential for the production of chitosan with physiochemical properties from a fungal source, growth studies were conducted using Mucor rouxii. Growth of the organism under a variety of conditions was studied to determine the effects on polymer molecular-weight distributions and biomass production. Modifications of processing protocols were also evaluated to examine the effects of yields of chitosan extracted from the fungal cell wall as well as molecular-weight distribution. This represents the first such study where these factors were correlated to the yield and molecular-weight distribution of chitosan. Of the growth parameters evaluated, length of incubation, culture volume, source of inorganic salt in defined medium, and medium component concentration in complex medium had an effect on biomass and MW distributions. Processing parameters affecting the amount of chitosan extracted were the type and strength of acid and the homogenization of cell wall material prior to refluxing. Overall, weight average molecular weights of chitosan varied up to 8-fold in studies relating to fungal age, while up to 2-fold changes in molecular weight were affected by pH, medium type, and culture vessel size.

19460 (PB–90-127580/XAB) **Advanced concepts in biomass production and biological pretreatment. Annual report, April 1988 to March 1989.** Hiler, E.A. Texas Agricultural Experiment Station, College Station, TX (USA). Apr 1989. 231p. Available from NTIS, PC A11/MF A02.

The overall objective of the research is to investigate fundamental processes for enhancing the efficiency of methane from sorghum systems. The report provides specifics of research activities in the Texas A and M biomass and biological pretreatment program sponsored by Gas Research Institute and co-funded by Texas Agricultural Experiment Station. Four research groups, each with specific tasks, are involved in the project: biomass production, quantity and quality, biological pretreatment and processing, long-term effects of land application of digester effluent, and systems modeling and analysis.

19461 (SERI/STR–232-3569) **Design and operation of an outdoor microalgae test facility: Final subcontract report.** Weissman, J.C. (Microbial Products, Inc., Vacaville, CA (USA)); Tillett, D.M.; Goebel, R.P. Microbial Products, Inc., Vacaville, CA (USA). Oct 1989. 56p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Contract No. XK-7-06113-1. Order Number DE89009493. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The objective of the project covered in this report is to establish and operate a facility in the American Southwest to test the concept of producing microalgae on a large scale. This microalgae would then be used as a feedstock for producing liquid fuels. The site chosen for this project was an existing water research station in Roswell, New Mexico; the climate and water resources are representative of those in the Southwest. For this project, researchers tested specific designs, modes of operation, and strains of microalgae; proposed and evaluated modifications to technological concepts; and assessed the progress toward meeting cost objectives.

19462 (VTT-SYMP–103, pp. 339-341) **Present situation and future trends of biomass production for energy in Bangladesh.** Ali, S. (Bangladesh Agricultural University, Mymensingh (Bangladesh). Department of Agricultural Chemistry). Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). 1989. (CONF-8806445–Vol.2: Seminar on non-waste technology, Espoo (Finland), 20-23 Jun 1988). In *Non-waste technology: Volume 2.* Order Number DE90748455. Available from NTIS (US Sales Only), PC A16/MF A01.

Poster presentation. BIOMASS/production; BANGLADESH/energy consumption; WOOD; BIOMASS; PRODUCTION; METHANE; BANGLADESH; MANURES

19463 **Panel discussion on the relative merits of woodgrass and SRIC.** Wright, L.L. (Environmental Sciences Div., Oak Ridge National Lab., Oak Ridge, TN (US)). pp. 1357 of Energy from biomass and wastes XII. Klass, D.L. Institute of Gas Technology, Chicago, IL (1989). DOE Contract AC05-84OR21400. (CONF-880215–: 12. energy from biomass and wastes, New Orleans, LA (USA), 15-19 Feb 1988).

A debate on the relative merits of woodgrass versus short-rotation intensive culture (SRIC) as alternative biomass-energy-feedstock production systems included a panel discussion on the relative merits of woodgrass and SRIC. Highlights of the panel discussion are summarized. The major portion of the text consists of four questions and the responses by the coauthors of this paper.

0909 Processing

Refer also to citation(s) 19165, 19460, 19461, 19462, 19463, 19469, 20411, 20412, 20413, 20433

19464 (CONF-8901100–3) **Experimental digester facility modifications and digester gas upgrading research.** Srivastava, V.J.; Biljetina, R.; Akin, C. Institute of Gas Technology, Chicago, IL (USA). [1989]. 16p. Sponsored by Institute of Gas Technology; Solar Energy Research Institute. From Solar Energy Research Institute (SERI) anaerobic digestion review meeting; Golden, CO (USA); 25-26 Jan 1989. Available from OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616.

The Institute of Gas Technology (IGT) has been participating in an experimental program at the Community Waste Research Facility (CWRF) located at the Walt Disney World Resort Complex, Orlando, Florida. Four institutions have formed a team to provide solutions to community waste treatment and disposal programs. Of primary importance to this research effort is the implementation of low-cost, energy-efficient waste treatment and recovery technologies and the net production of energy (methane) from biomass and waste resources. The production of methane is being studied in a novel, high-rate digester. During 1988, we were responsible for modifying the Experimental Test Unit (ETU) to permit dry solids feeding of refuse-derived fuel (RDF) and for conducting bench-scale experiments to evaluate techniques for efficient removal of carbon dioxide produced during anaerobic digestion.

19465 (PB-90-127614/XAB) **Enzymological and genetic studies of one-carbon reactions in the pathway of acetate utilization by methanogenic bacteria. Annual report, February 1986-December 1986.** Ferry, J.G. Virginia Polytechnic Inst. and State Univ., Blacksburg, VA (USA). Jan 1987. 93p. Available from NTIS, PC A05/MF A01.

The project focused on determining the biochemical pathway and mechanisms of acetate conversion to methane in methanogenic bacteria. A corrinoid cofactor was discovered in the carbon monoxide dehydrogenase complex previously shown to be involved in the pathway of acetate conversion to methane. The genetic control mechanism for the regulation of formate dehydrogenase synthesis was determined. Results show that the enzyme is autoregulated at the level of transcription.

19466 (VTT-SYMP-103, pp. 181-185) **Testing of landfill gas productivity.** Myslivecek, J. (Fuel Research Institute, Praha (Czechoslovakia)); Konrad, B.; Straka, F. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). 1989. (CONF-8806445-Vol.2: Seminar on non-waste technology, Espoo (Finland), 20-23 Jun 1988). In *Non-waste technology: Volume 2.* Order Number DE90748455. Available from NTIS (US Sales Only), PC A16/MF A01.

Landfill sites need not represent only an ecological problem but they may also serve as a valuable and continuously renewing energy source. A landfill site can today ensure an complete elimination of liquid and gaseous pollutants, provide gas of high purity for energy or heat generation, eliminate the danger of gas migration to the vicinity and enable a rapid and efficient recultivation of the landfill site. In order, to verify the production capacities, parameters of the pumping system and gas composition, a method of field pumping tests has been developed and tested, comprising the measurements of changes in the gas composition and in the pressure conditions in the landfill body at different pumping outputs. The test resulted in the determination of the dynamic composition of produced gas under the conditions of the maximum production rate and of the distances of wells, as well as in the estimation of the maximum specific production rate per one well.

19467 (VTT-SYMP-103, pp. 199-206) **Thermochemical treatment of solid waste for biodegradation.** Taner, F. (C. U. Arts and Science Faculty, Adana (Turkey). Chemistry Department); Kimyosen, U.; Boztepe, H. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). 1989. (CONF-8806445-Vol.2: Seminar on non-waste technology, Espoo (Finland), 20-23 Jun 1988). In *Non-waste technology: Volume 2.* Order Number DE90748455. Available from NTIS (US Sales Only), PC A16/MF A01.

Aqueous slurries of the solid waste (20% by weight) obtained from a waste water treatment plant and paper manufacture in Tasucu, were treated with acetic acid (10% weight of solid) at 200 deg C, 300 deg C and 350 deg C in a high pressure autoclave for one hour starting with 0.1 MPa initial inert gas pressure. The aqueous phases were separated and the solid-oil phases were washed with water. The combined washwater and aqueous phases were digested anaerobically at 37 deg C in a waterbath. The samples taken out at three-day intervals were analysed to determine pH, COD and BOD_5 concentrations. It was found that as the temperature of the thermo-chemical treatment, increases, anaerobic biodegradability increases. It can be concluded that the aqueous layers obtained from the thermochemical treatment can be used for biogas production.

19468 **Production costs of hydrocarbon fuels from biomass.** Stevens, D.J. (Pacific Northwest Lab., P.O. Box 999, Richland, WA (US)); Wan, E.I. pp. 1357 of Energy from biomass and wastes XII. Klass, D.L. Institute of Gas Technology, Chicago, IL (1989). DOE Contract AC06-76RL01830. (CONF-880215-: 12. energy from biomass and wastes, New Orleans, LA (USA), 15-19 Feb 1988).

This paper presents an evaluation of production costs for hydrocarbon fuels from two advanced biomass-to-gasoline processes. These include one conceptual process where biomass is rapidly pyrolyzed and the resulting biocrude oil is hydrotreated to gasoline hydrocarbons. A second conceptual process is also considered where biomass is pyrolyzed and the intermediate biocrude vapors are upgraded over zeolite catalysts. A technoeconomic analysis is performed for these two concepts based both on currently attainable experimental results as well as projected results assumed to be attainable with additional research.

0910 Properties and Composition

Refer also to citation(s) 19459

0930 Economic, Industrial, and Business Aspects

Refer also to citation(s) 19468, 19732, 19839

19469 (HNEI-89-1004) **Hawaii Integrated Biofuels Research Program: Phase 1, Final report.** Takahashi, P.K. Hawaii Natural Energy Inst., Honolulu, HI (USA). Oct 1989. 200p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Order Number DE90006885. Available from NTIS, PC A08/MF A01 - OSTI.

Hawaii provides a unique environment for production of biomass resources that can be converted into renewable energy products. The purpose of this work is to evaluate the potential of several biomass resources, including sugarcane, eucalyptus, and leucaena, particularly for utilization in thermochemical conversion processes to produce liquid or gaseous transportation fuels. This research program supports ongoing efforts of the Biofuels and Municipal Solid Waste Technology (BMWT) Program of the Department of Energy (DOE) and has goals that are consistent with BMWT. The Hawaii Natural Energy Institute (HNEI) work completed here consists of research activities that support two of the five renewable fuel cycles being pursued by DOE researchers. The results are directly applicable in the American territories throughout the Pacific Basin and the Caribbean, and also to many parts of the United States and worldwide. The Hawaii Integrated Biofuels Research Program is organized into the following six research tasks, which are presented as appendices in report form: Biomass Resource Assessment and System Modeling (Task 1); Bioenergy Tree Research (Task 2); Breeding, Culture, and Selection of Tropical Grasses for Increased Energy Potential (Task 3); Study of Eucalyptus Plantations for Energy Production in Hawaii (Task 4); Fundamental Solvolysis Research (Task 5); and Effects of Feedstock Composition on Pyrolysis Products (Task 6). 54 refs., 35 figs., 55 tabs.

19470 (VTT-SYMP-103, pp. 351) **Small scale charcoal production from biomass for integrated utilization.** Kumar, A. (Indian Institute of Technology, New Delhi (India). Centre for Rural Development and Technology); Maheshwari, R.C. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). 1989. (CONF-8806445-Vol.2: Seminar on non-waste technology, Espoo (Finland), 20-23 Jun 1988). In *Non-waste technology: Volume 2.* Order Number DE90748455. Available from NTIS (US Sales Only), PC A16/MF A01.

Poster presentation. CHARCOAL/production; BIOMASS; CHARCOAL; PRODUCTION; WOOD FUELS; SOLID FUELS; WOOD; FORESTS; KILNS; EFFICIENCY; ECONOMICS

0980 Waste Management

Refer also to citation(s) 19821, 19831

10 SYNTHETIC FUELS

1002 Production

Refer also to citation(s) 19165, 19185

19471 (CONF-881205–4) **Important factors in biotechnological processes involving methanotrophs.** Kelley, R.L.; Conrad, J.R.; Hoefer, D.E.; Desai, A.; Srivastava, V.J.; Akin, C. Institute of Gas Technology, Chicago, IL (USA). [1988]. 74p. Sponsored by Institute of Gas Technology. From Symposium on coal, oil, and gas biotechnology; New Orleans, LA (USA); 5-7 Dec 1988. Available from OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616.

Although the first methane-oxidizing organism was isolated over 80 years ago, research on these microorganisms was confined to a few labs and only recently methanotrophy started to gain industrial interest. We have begun an effort on the bioconversion of methane to produce useful chemicals at the Institute of Gas Technology (IGT). Important physiological, engineering, and economic constraints on the commercialization of methanotrophic technologies are being addressed. We also have researched innovative separation techniques to recover products from the growth medium and have developed reactor designs to improve the overall mass transfer of methane. In this paper, we will concentrate on identifying and discussing some of the important parameters for the commercialization of this technology and describe some of the work that we have conducted at IGT. 80 refs., 38 figs., 13 tabs.

19472 (DOE/PC/90013–T11) **Optimum catalytic process for alcohol fuels from syngas: Eleventh quarterly technical progress report, July–September 1989.** Union Carbide Corp., South Charleston, WV (USA). Solvents and Coatings Materials Div. 31 Oct 1989. 36p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-86PC90013. Order Number DE90007188. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The contract work is composed of three tasks. Task 1, the preparation of a Project Work Plan, has been completed. Task 2 comprises the chemical investigation of novel and existing catalysts for the production of fuel alcohols from syngas, either directly or through a step-wise process. Task 3 consists of engineering activities which will support the chemical investigations and develop economic evaluations and process conceptualization. Tasks 2 and 3 will proceed for the entire duration of the program. In current work under Task 2, the effort has been mainly on heterogeneous catalysts. Novel systems which may exhibit superior behavior are being investigated. Task 3 work has involved engineering support for the chemical investigations. Economic evaluations of a base case process for conversion of syngas to fuel alcohols were also pursued. Task 3 work has also involved experiments with selected catalytic systems. Further work in Task 3 will include the evaluation of slurry-catalyzed processes for the production of fuel alcohols or their derivatives. 5 figs., 15 tabs.

19473 (DOE/PC/90014–T6) **Upgrading Fischer-Tropsch LPG [liquefied petroleum gas] with the Cyclar process.** Gregor, J.H.; Gosling, C.D.; Fullerton, H.E. UOP, Inc., Des Plaines, IL (USA). 28 Apr 1989. 245p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-86PC90014. Order Number DE90006498. Available from NTIS, PC A11/MF A01 - OSTI.

The use of the UOP/BP Cyclar® process for upgrading Fischer-Tropsch (F-T) liquefied petroleum gas (LPG) was studied at UOP®. The Cyclar process converts LPG into aromatics. The LPG derived from F-T is highly olefinic. Two routes for upgrading F-T LPG were investigated. In one route, olefinic LPG was fed directly to a Cyclar unit (Direct Cyclar). The alternative flow scheme used the Huels CSP process to saturate LPG olefins upstream of the Cyclar unit (Indirect Cyclar). An 18-run pilot plant study verified that each route is technically feasible. An economic evaluation procedure was designed to choose between the Direct and Indirect Cyclar options for upgrading LPG. Four situations involving three different F-T reactor technologies were defined. The main distinction between the cases was the degree of olefinicity, which ranged between 32 and 84 wt % of the fresh feed. 8 refs., 80 figs., 44 tabs.

19474 **Fischer-Tropsch synthesis with iron catalysts.** Tau, L.M. (Center for Applied Energy Research, Lexington, KY (USA)); Dabbagh, H.A.; Wilson, T.P.; Davis, B.H. *Applied Catalysis (Netherlands)*, 56(1): 95-106 (1 Dec 1989).

The addition of an alcohol to a syngas feed to an alkali-free iron catalyst has an influence upon both catalytic activity and hydrocarbon product distribution within each carbon number. Furthermore, it appears that adding alkali to an iron catalyst alters activity and product distribution in the same direction as adding an alcohol to the syngas feed. It is not possible to decide whether these changes are caused by alcohol acting to physically block adsorption sites or whether the changes are effected through an electronic effect whereby one adsorbed alcohol effects the catalytic character of more than one site. 8 figs., 31 refs.

1007 Economic, Industrial, and Business Aspects

19475 (CONF-8910248–5) **Alternative fuels R&D needs: Program directions.** Graves, R.L. Oak Ridge National Lab., TN (USA). [1989]. 11p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. From Annual automotive technology development contractors coordination meeting; Dearborn, MI (USA); 23-26 Oct 1989. Order Number DE90007053. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper describes the findings of a review of alternative fuel utilization research and development needs, as well as activities planned to meet those needs in the Department of Energy Alternative Fuels Utilization Program (AFUP). The technology status review was accomplished through numerous visits to auto and engine manufacturers, through workshops with engine and fuel industries, and visits to universities and laboratories. Research projects planned in AFUP will address diesel fuel chemistry effects on emissions, ignition and combustion of methanol for heavy-duty engines, and methanol engine war and lubrication in the Federal Methanol Fleet vehicles. 8 refs., 3 figs.

13 HYDRO ENERGY

Refer also to citation(s) 19458

1303 Plant Design and Operation

Refer also to citation(s) 19477

19476 **Usable hydro capacity and electric utility production simulation and reliability calculations.** Staschus, K. (Pacific Gas and Electric Co., San Francisco, CA (US)); Bell, A.; Cashman, E. pp. 472 of Proceedings of the 1989 computer applications conference. IEEE Service Center, Piscataway, NJ (1989). (CONF-8905170–: IEEE power industry computer applications conference, Seattle, WA (USA), 1-5 May 1989).

Hydroelectric plants can be modeled in equivalent load duration curve (ELDC) based production simulation and reliability models in two ways: through peakshaving and by dispatching the hydro plants against the ELDC. The subject of this paper is a comparison of the two methods with respect to the implied usability of the hydro capacity. Test results indicate that the peakshaving approach is more appropriate, according to this comparison criterion.

1305 Economic, Industrial and Business Aspects

Refer also to citation(s) 19477

1307 Power-Conversion Systems

Refer also to citation(s) 19858

19477 (EPRI-GS–6669) **Pumped-storage planning and evaluation guide: Final report.** Chen, H.H. (Harza Engineering Co., Chicago, IL (USA)). Electric Power Research Inst., Palo Alto, CA (USA); Harza Engineering Co., Chicago, IL (USA); Tudor Engineering Co., San Francisco, CA (USA); Electric Power Consulting, Inc.,

Santa Clara, CA (USA); Jenkins (Taber), Chattanooga, TN (USA). c Jan 1990. 527p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

A comprehensive and stand-alone guide is offered for the preliminary evaluation of pumped-storage sites. The Guide Book is designed to help (a) evaluate performance and benefits of pumped storage in a utility system, including dynamic benefits, (b) identify the physical characteristics of a site suitable for pumped-storage development, (c) establish the site's energy storage potential and installed capacity, (d) estimate capital cost, and annual operation and maintenance expense, and (e) conduct an economic analysis. A PC-based computer program has been written and is included in the Guide Book to assist in benefit analysis. The concept of dynamic benefits is explained, and how pumped storage contributes to them is described. Six of the major power system generation planning models are evaluated to help utility planners select the model best suited for their application. A methodology is provided to help planners screen and select sites encompassing cost, benefit, environmental, and regulatory factors. Step-by-step procedures are described, one simplified and the other more detailed, to facilitate the use of the guide. Background descriptions are provided to assist those unfamiliar with pumped-storage practice. A series of cost curves are provided to permit the development of a preliminary capital cost estimate for a site, based on a few key parameters which define the physical characteristics of the site.

14 SOLAR ENERGY

Refer also to citation(s) 19458

1401 Resources and Availability

Refer also to citation(s) 19694, 19695

19478 (LA–11728-C, pp. 146-152) **The Soviet-American gallium experiment (SAGE).** Garvey, G.T. Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

The Soviet-American Gallium Experiment (SAGE) undertaking is a multi-institutional collaboration among scientists from the Institute for Nuclear Research, Moscow (INR), Los Alamos National Laboratory (LANL), and several US universities. It's purpose is to measure the number of low-energy electron neutrinos emitted from the Sun that arrive at this planet. As such, it is an extremely important experiment, touching on fundamental physics issues as well as solar dynamics. In contrast to the strategic overviews, plans, and hopes for intentional collaboration presented earlier today, SAGE is an ongoing working effort with high hopes of producing the first measurement of the Sun's low-energy flux. There are several international physics collaborations involving US and Soviet scientists at the large accelerator installations throughout the world. As the scale of research gets ever larger, requiring ever more resources and then larger collaborations. Much physics research lies solely in the realm of basic research so that governments feel easier about collaborations. Contacts between the US and USSR scientists interested in nuclear and particle physics goes back to the nineteen fifties and have continued with only minor interruptions since then. Over the past two decades the principal oversight of these activities has been through the Joint Coordinating Committee on the Fundamental Properties of Matter, supported by the DOE in the US and the State Committee for Atomic Energy in the USSR. The Academies of Science of both countries have been very helpful and supportive. Each venture has some distinguishing features; in the case of SAGE, the unique aspects are the collaboration between Soviet scientists and scientists at a DOE weapons laboratory and the fact that the experiment is carried out in a remote region of the USSR. The particular problems caused are discussed. 3 refs., 3 figs.

19479 (SERI/TR–215-3513B) **Spectral solar radiation data base documentation: Volume 2.** Riordan, C.J.; Myers, D.R.; Hulstrom, R.L. Solar Energy Research Inst., Golden, CO (USA). Jan 1990. 401p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Order Number DE89009448. Available from NTIS, PC A18/MF A01 - OSTI.

The Solar Energy Research Institute (SERI), Electric Power Research Institute, Florida Solar Energy Center, and Pacific Gas and Electric Company cooperated to produce a spectral solar radiation data base representing a range of atmospheric conditions. These data will help to characterize the neutral variability in the spectral (color) content to outdoor solar radiation so that the sensitivity of spectrally selective solar devices (such as photovoltaics) to these variations can be studied quantitatively. Volume 1 of this report documents the history, approach, content, and format of the data base; Volume 2 contains graphs and field notes for each of the spectral data sets. The data reside on magnetic tape at SERI.

1404 Environmental Aspects

Refer also to citation(s) 19694

19480 (SAND–89-1506C) **Enhancement of processes for solar photocatalytic detoxification of water.** Pacheco, J.E.; Tyner, C.E. Sandia National Labs., Albuquerque, NM (USA). [1990]. 5p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC04-76DP00789. (CONF-900449–5: ASME international solar energy conference, Miami, FL (USA), 1-4 Apr 1990). Order Number DE90003949. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A solar-driven photocatalytic process is being developed to destroy low levels of toxic organics in water. Parabolic troughs with a glass pipe reactor and heliostats (large tracking mirrors) with a falling-film reactor were used to conduct engineering-scale solar detoxification of water experiments. We have assessed the effect of catalyst (titanium dioxide) loading and hydrogen peroxide concentration on the destruction of a model organic compound, salicylic acid. We found the optimal catalyst loading to be 0.1% for the conditions of 30 ppM salicylic acid and 300 ppM hydrogen peroxide. Hydrogen peroxide affected the reaction rates significantly, increasing the reaction rate over 4 times for stoichiometric amounts and more than 19 times for 10 times the stoichiometric amount. Destruction rates appear to be linearly proportional to the ultraviolet light intensity, though more data are needed to fully establish the relation. Initial tests with an actual water pollutant, trichloroethylene, demonstrated destruction from 1.2 ppM to less than 50 ppB in less than 5 minutes of exposure with a trough system. 15 refs., 6 figs.

1405 Solar Energy Conversion

Refer also to citation(s) 19513, 19711, 19869, 19957, 19959, 19960, 19961, 20006

19481 (DOE/ER/13545–3) **Dynamics of charge-transfer excited states relevant to photochemical energy conversion: Progress report, June 1, 1986–December 15, 1988.** Lim, E.C. Wayne State Univ., Detroit, MI (USA). [1988]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER13545. Order Number DE90007206. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Excited states of molecular dimers can be important intermediates of photoinduced charge transfer (CT) processes of bichromophoric molecules composed of two identical moieties, just as an excited-state-complex (exciplex or electronically excited electron donor-acceptor complex) is known to be an important precursor of CT processes involving two different chromophores. The study of structure, energetics, and dynamics of excited states of molecular dimers of aromatic molecules are therefore important for the elucidation of the photoinduced CT processes involving two identical aromatic moieties. With these considerations in mind, we began to reinvestigate the dimeric excited states of dinaphthylalkanes and related molecules, which we had previously studied in a slightly different context. Both the dimeric species derived from

excitation of one aromatic moiety (excimers) and that due to excitation of both aromatic moieties (bicimers) are investigated in relation to their possible role in photoinduced CT processes.

19482 (SAND–89-1811C) **Investigation of a Direct Catalytic Absorption Reactor for hazardous waste destruction.** Skocypec, R.D.; Hogan, R.E. Jr. Sandia National Labs., Albuquerque, NM (USA). [1990]. 18p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC04-76DP00789. (CONF-900449–6: ASME international solar energy conference, Miami, FL (USA), 1-4 Apr 1990). Order Number DE90004211. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Direct Catalytic Absorption Reactors (DCARs) use a porous solid matrix to volumetrically absorb solar energy. This energy is used to promote heterogeneous chemistry on the catalytic surface of the absorber with fluid-phase reactant species. Experimental efforts at Sandia National Laboratories (SNL) are using a DCAR to destroy hazardous chemical waste. A numerical model, previously developed to analyze solar volumetric air-heating receivers and methane-reforming reactors, is extended in this work to include the destruction of a chlorinated hydrocarbon chemical waste, 1,1,1-trichloroethane ($C_2H_3Cl_3$). The model includes solar and infrared radiation, heterogeneous chemistry, conduction in the solid absorber, and convection between the fluid and solid absorber. 8 refs., 8 figs.

19483 (SERI/PR–212-3494, pp. 62-136) **Amorphous silicon research.** Crandall, R. Solar Energy Research Inst., Golden, CO (USA). Jul 1989. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. In *Solid State Photovoltaic Research Branch annual report, FY 1988.* Order Number DE89009463. Available from NTIS, PC A12/MF A01 - OSTI.

Much of the research begun in FY 1988 was strengthened by two new and powerful characterization techniques that have improved our understanding of microstructure and metastability. The extensive work on microstructure carried out at SERI in the past was based on inferences about microstructure from infrared absorption and band tail broadening. This year, we were successful in making small-angle x-ray scattering (SAXS) measurements on a-Si:H that are two or three orders of magnitude more sensitive than any previous measurements. This has permitted us to determine the microvoid size and density distribution on device-quality material. This will go a long way in predicting new methods to improve amorphous silicon. A new trap spectroscopy technique was developed that allows us to determine the distribution of trapped holes in valence band tail states. These states are particularly important to study because they are instrumental in determining photoconductivity. Further, we have been able to show that they are the precursor to light-induced dangling bond formation. 209 refs., 35 figs., 4 tabs.

19484 (SERI/PR–212-3494, pp. 137-190) **Polycrystalline thin films.** Noufi, R. Solar Energy Research Inst., Golden, CO (USA). Jul 1989. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. In *Solid State Photovoltaic Research Branch annual report, FY 1988.* Order Number DE89009463. Available from NTIS, PC A12/MF A01 - OSTI.

This task entails the fabrication and investigation of thin films and photovoltaic (PV) devices of ternary and quaternary semiconductor materials. The approach is to study the fundamental properties of the materials and relate those properties to photovoltaic applications. The materials of emphasis are $CuInSe_2$, with a band gap of about 1.0 eV, and $CuGaSe_2$, with a band gap of about 1.7 eV. We identify and study fundamental material properties crucial to the performance of the device, such as (1) the stoichiometry and defect chemistry of the films; (2) the effect of processing parameters, e.g., arrival rates of the elements at the substrate, the substrate temperature, and the nature of the substrate; (3) the effect annealing and composition on the fundamental properties; (4) modification of the physical and chemical properties of the films to achieve better device performance parameters, especially the open-circuit voltages; (5) demonstrate the viability of the electrodeposition of $CuInSe_2$ as a low-cost, large-area process; and (6) help solve fundamental problems that will help the $CuInSe_2$ technology become viable. 74 refs., 34 figs., 4 tabs.

19485 (SERI/PR–212-3494, pp. 191-212) **III-V high-efficiency photovoltaic cells.** Olson, J.M. Solar Energy Research Inst., Golden, CO (USA). Jul 1989. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. In *Solid State Photovoltaic Research Branch annual report, FY 1988.* Order Number DE89009463. Available from NTIS, PC A12/MF A01 - OSTI.

The objective of this work is to develop an understanding of, and solutions to, the problems inherent in the fabrication of high-efficiency, multijunction cascade solar cells using such III-V semiconductor materials as GaAs, GaP, InP, GaInP, and AlGaAs. The major areas of research include metal-organic chemical vapor deposition (MOCVD), defect analysis and control, and device fabrication and characterization. Most of the past year's work has bee directed toward the development of the lattice- and current-matched $Ga_{0.5}In_{0.5}P$/GaAs cascade solar cell. This cell has a one-sun, air-mass (AM)1.5 theoretical efficiency of 34%, but exhibits few of the problems typical of lattice-mismatched heterostructures. Progress and highlights in this area are presented and discussed. 60 refs., 10 figs., 2 tabs.

19486 (SERI/PR–212-3494, pp. 213-240) **Solid state theory.** Zunger, A. Solar Energy Research Inst., Golden, CO (USA). Jul 1989. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. In *Solid State Photovoltaic Research Branch annual report, FY 1988.* Order Number DE89009463. Available from NTIS, PC A12/MF A01 - OSTI.

The objective of this group is to conduct basic and applied research in theoretical solid-state physics pertaining to a fundamental understanding of the differe elements constituting a photovoltaic solar cell. This includes characterization and prediction of electronic properties of relevant (pure) bulk semiconductors, surface properties, interface properties, semiconductor alloys, superlattices, defects, and impurity states in semiconductors. Furthermore, this effort is directed to developing new theoretical techniques, when needed, capable of addressing complex new problems. The approach is based on a detailed quantum mechanical description of the system rather than phenomenological modeling. Current work has been directed to the following: Coherent epitaxial effects on pure compounds and alloys; Optical properties of alloys; Alloy phase diagrams and alloy thermodynamics; Direct-gap ultrathin superlattices made of indirect-gap constituents; Thermodynamics and stability of ultrathin superlattices; Non-isovalent superlattices: Si-GaP; and Charge density maps for zinc-blende semiconductors.

19487 (SERI/PR–212-3494, pp. 241-251) **Laser Raman and luminescence spectroscopy.** Mascarenhas, A.; Pankove, J. Solar Energy Research Inst., Golden, CO (USA). Jul 1989. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. In *Solid State Photovoltaic Research Branch annual report, FY 1988.* Order Number DE89009463. Available from NTIS, PC A12/MF A01 - OSTI.

Spectroscopic studies on solid-state materials used for photovoltaic applications provide information on their optical, electronic, and lattice dynamical properties. Such information is vital to understanding the intrinsic and extrinsic aspects of performance limitations when such materials are used to construct photovoltaic devices. The diagnostic techniques that we have emphasized are primarily optical: photoluminescence, Raman scattering, and photoreflectance. During the past year, we have investigated the following topics: (1) characterization of fluorinated microcrystalline silicon-hydrogen alloy films by Raman spectroscopy; (2) characterization ion-beam hydrogenated amorphous silicon hydrogen alloy films by Raman spectroscopy; (3) oxygen-isotope-effect studies on superconducting Bi-Sr-Ca-Cu-O; and (4) copper-isotope-effect studies on superconducting $YBa_2Cu_3O_{7-x}$. A brief description of these investigations is provided in the following sections. Since our work on the isotope effect on superconductors is of significant importance, this topic will be treated more elaborately. 24 refs., 11 figs.

19488 (SERI/STR–211-3612) **Investigations of $CuInSe_2$ thin films and contacts: Annual subcontract report, September 1988–October 1989.** Nicolet, M.A. (California Inst. of Tech., Pasadena, CA (USA)). California Inst. of Tech., Pasadena, CA (USA). Jan 1990. 12p. Sponsored by U.S. DOE Conservation &

Renewable Energy. DOE Contract AC02-83CH10093. Contract XB-8-07133-1. Order Number DE90000301. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report describes various studies of copper indium diselenide ($CuInSe_2$) thin-film materials and contacts. The $CuInSe_2$ films prepared on substrates of glass or Mo-coated glass show the same polycrystalline structure, a Cu-rich composition, and a preferential grain orientation; however, they exhibit different surface morphologies, grain sizes, and shapes. Rutherford backscattering measurements were performed on different samples before and after 600°C annealing. This treatment induced Se evaporation from the $CuInSe_2$ films and interdiffusion between Mo and $CuInSe_2$.

19489 The effect of different module configurations on the radiation tolerance of multijunction solar cells. Gee, J.M. (Sandia National Labs., Albuquerque, NM (USA)); Curtis, H.B. pp. 1671 of Twentieth IEEE photovoltaic specialists conference, 1988. IEEE Service Center, Piscataway, NJ (1988). DOE Contract AC04-76DP00789. (CONF-880965–: 20. IEEE photovoltaic specialists conference, Las Vegas, NV (USA), 26-30 Sep 1988).

The effect of different module configurations on the performance of multijunction (MJ) solar cells in a radiation environment is discussed. Module configuration refers to the electrical circuit in which the subcells of the multijunction cell are wired. Experimental data for AlGaAs, GaAs, InGaAs, and silicon single-junction concentrator cells subjected to 1-MeV electron irradiation was used to calculate the expected performance of AlGaAs/InGaAs, AlGaAs/silicon, GaAs/InGaAs, and GaAs/silicon MJ concentrator cells. These calculations included independent, series, and voltage-matched configurations. The module configuration are found to have a significant impact on the radiation tolerance characteristics of MJ cells.

19490 Reliability testing of cell assemblies for photovoltaic concentrator modules. Chiang, C.J. (Sandia National Labs., Albuquerque, NM (USA)); Blankenau, S.J. pp. 1671 of Twentieth IEEE photovoltaic specialists conference, 1988. IEEE Service Center, Piscataway, NJ (1988). DOE Contract AC04-76DP00789. (CONF-880965–: 20. IEEE photovoltaic specialists conference, Las Vegas, NV (USA), 26-30 Sep 1988).

Reliability testing is crucial to the design of improved cell assemblies and to the assessment of their reliability. Thermal cycling has proven to be the most difficult reliability test for cell assemblies to survive. This paper describes correlation of artificial thermal cycling with field operating through two separate experimental investigations. The first was a study of two sets of identical cell assemblies; one used in the field and the other stored. The degradation mechanism was cracking in the solder attaching the feet of the top contact to the cell. For this failure mechanism and this type of cell assembly, 125 thermal cycles of a type specified by our qualification test were found to cause the same amount of degradation as 4.7 years of use in the field. The second investigation, currently in progress, involves thermal cycling at temperatures simulating field operation but at higher cycling frequencies. By comparing identical parts cycled at different frequencies, the effect of frequency on rate of degradation can be determined. Then, a number of thermal cycles at a higher frequency can be related to an equivalent number of thermal cycles at the lower frequencies encountered in actual use.

19491 The Atmospheric Optical Calibration System. Cannon, T.W. (Solar Energy Research Inst., Golden, CO (USA)); Hulstrom, R.L. pp. 1671 of Twentieth IEEE photovoltaic specialists conference, 1988. IEEE Service Center, Piscataway, NJ (1988). DOE Contract AC02-83CH10093. (CONF-880965–: 20. IEEE photovoltaic specialists conference, Las Vegas, NV (USA), 26-30 Sep 1988).

The authors describe an instrument, known as the Atmospheric Optical Calibration System (AOCS) developed to provide low-cost measurements of atmospheric optical and spectral solar irradiance conditions pertinent to photovoltaic (PV) device performance measurements. Optical properties of interest are molecular and aerosol scattering, aerosol absorption, water vapor absorption and the ratio of diffuse to global horizontal photon flux densities for the region 0.40 to 0.70 micrometer. Measurements are used as input to a model to estimate the spectral solar irradiance (.3 to 4 micrometers) impingement on the device. Measurements using the AOCS will be used by the PV community to measure, in real time, the effects of atmospheric optical and spectral solar irradiance on device performance.

19492 The DOE/SERI polycrystalline thin film subcontract program. Zweibel, K. (Solar Energy Research Inst., Golden, CO (USA)); Ullal, H.S.; Mitchell, R.L. pp. 1671 of Twentieth IEEE photovoltaic specialists conference, 1988. IEEE Service Center, Piscataway, NJ (1988). DOE Contract AC02-83CH10093. (CONF-880965–: 20. IEEE photovoltaic specialists conference, Las Vegas, NV (USA), 26-30 Sep 1988).

The Solar Energy Research Institute manages research subcontracts to develop polycrystalline thin film solar cells to meet cost-competitive goals for utility-scale electricity. The program is funded through the Department of Energy. Highlights include the achievement of the highest efficiency thin film square-foot module and the highest efficiency single-junction thin film cell (both $CuInSe_2$); and the highest efficiency CdTe cell and CdTe square-foot module. This paper gives a summary of the status of polycrystalline thin films; the requirements for them to meet the DOE cost-competitive goals; program highlights; research issues; and future plans.

19493 Polycrystalline CdTe on $CuInSe_2$ cascaded solar cells. Meyers, P.V. (Ametek Applied Materials Lab., Harleysville, PA (US)); Liu, C.H.; Russell, L.; Ramanathan, V.; Birkmire, R.W.; McCandless, B.E.; Phillips, J.E. pp. 1671 of Twentieth IEEE photovoltaic specialists conference, 1988. IEEE Service Center, Piscataway, NJ (1988). (CONF-880965–: 20. IEEE photovoltaic specialists conference, Las Vegas, NV (USA), 26-30 Sep 1988).

It is well known that II-VI and related chalcopyrite compounds provide many candidate materials for multijunction cascaded solar cells with efficiencies about 15%. In this paper the authors present experimental results obtained using a CdS/CdTe/ZnTe top cell on a CdS/$CuInSe_2$ bottom cell. Single cells of each type have exhibited 11% efficiency. A mechanically stacked CdTe-$CuInSe_2$ tandem cell was fabricated with an efficiency of 9.9%. The current of the $CuInSe_2$ cell was limited by the transmission through the CdTe cell.

19494 Experiments on the modification of the bi-layer structure in CdS/CuInSe2 devices. Tuttle, J.R. (Solar Energy Research Inst., Golden, CO (USA)); Ruth, M.; Albin, D.; Mason, A.; Noufi, R. pp. 1671 of Twentieth IEEE photovoltaic specialists conference, 1988. IEEE Service Center, Piscataway, NJ (1988). DOE Contract AC02-83CH10093. (CONF-880965–: 20. IEEE photovoltaic specialists conference, Las Vegas, NV (USA), 26-30 Sep 1988).

In this paper, the authors report on preliminary studies into modifications on the standard bilayer approach to CdS/$CuInSe_2$ device fabrication. The incorporation of $CuIn_{1-x}Ga_xSe_2$ and $CuIn_{1-x}Al_xSe_2$ quaternary alloys into the Space Charge Region substantially enhances open-circuit voltage. Short-circuit current losses are minimized if thin discrete layers of these alloys are placed at the selenide/sulfide interface. Additionally, placing $CuGaSe_2$ at the back contact of the device enhances the near-infrared spectral response. The application of cyanide and chromium based chemical treatments improves overall device performance through the removal of bulk secondary phases and reduction of interface recombination centers.

19495 Characterization of window layers in $CuInSe_2$ thin-film solar cells. Shafarman, W.N. (Delaware Univ., Newark, DE (USA). Inst. of Energy Conversion (USA)); Birkmire, R.W. pp. 1671 of Twentieth IEEE photovoltaic specialists conference, 1988. IEEE Service Center, Piscataway, NJ (1988). (CONF-880965–: 20. IEEE photovoltaic specialists conference, Las Vegas, NV (USA), 26-30 Sep 1988).

Electrical and optical properties of (CdZn)S:In, (CdZn)S:In/ITO, and ZnO windows in $CuInSe_2$ thin film solar cells are measured and compared to the properties of equivalent window layers deposited on glass. The resistivity and absorption edge of (CdeZn)S:In films are characterized as a function of In dopant concentration and Zn content and it is shown that the Burstein-Moss shift decreases as the Zn content is raised. Air heat treatments, used to increase V_{oc} and efficiency of $CuInSe_2$ cells, increase the resistivity and decrease the absorption edge of (CdZn)S:In window

layers. $CuInSe_2$/ZnO cells have higher J_{sc} than cells with (CdZn)S windows but low V_{oc} and efficiency.

19496 Photoconductive circuit element pulse generator. Rauscher, C. To Dept. of Energy, Washington, DC. USA Patent 4,870,295. 26 Sep 1989. Filed date 3 Mar 1989. USA Patent Application 7 320,433. Int. Cl. H01J 40/14. 8p. Available from Patent and Trademark Office, Box 9, Washington, DC 20232.

This patent describes a pulse generator for characterizing semiconductor devices at millimeter wavelength frequencies where a photoconductive circuit element (PCE) is biased by a direct current voltage source and produces short electrical pulses when excited into conductance by short laser light pulses. The electrical pulses are electronically conditioned to improve the frequency related amplitude characteristics of the pulses which thereafter propagate along a transmission line to a device under test.

1406 Photovoltaic Power Systems

Refer also to citation(s) 19489

19497 (DOE/CE/33007–T2) **Low earth orbiting satellite for international information exchange system: Final report.** Garriott, G.L. Volunteers in Technical Assistance, Arlington, VA (USA). 21 Nov 1989. 32p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG01-87CE33007. Order Number DE90007186. Available from NTIS, PC A03/MF A01 - OSTI.

VITA exceeded the goals outlined in the grant, especially in the development of networks of ground stations which can ultimately uplink to PACSAT. The University of Surrey (UK) designed and constructed the store and forward payloads. VITA demonstrated and helped install terrestrial networks in several countries for various agencies. This document is the second deliverable item under the VITA PACSAT Payload Contract (SST 88/157). This Prototype Report describes the design and construction of the Prototype PACSAT payload, which will be used for in-orbit tests on UoSAT satellite. This Report also notes how the goals set forth in the Preliminary System Specification have been met in the Prototype Payload design. The most recent formal report under this contract was the Preliminary System Specification of 25 March 1988. After that report, the in-orbit test opportunity for the VITA PACSAT Payload was re-scheduled. A review of the new test mission is presented in Section 2.

19498 (IE-MOEI–88/0100, pp. 50) **The storage of photovoltaic energy.** Manassen, J. (Weizmann Inst. of Science, Materials Research Dept., Rehovot, (Israel)). Ministry of Energy and Infrastructure, Jerusalem (Israel). Jun 1988. (CONF-880609–: Energy 88: 2. International congress and exhibition on energy, Tiberias (Israel), 5-10 Jun 1988). In *Energy 88. The 2nd international congress and exhibition on energy. Abstracts.* Available from COSTI P.O.B 20125, TEL-AVIV 61201.

Abstract only.

At present the projected use of electrical energy, generated by photovoltaic stations, is to supply electricity during peak hours, when there is also a peak in the solar intensity. In such a way there is no need for storage and energy is delivered to the power company when it most needs it. This is a good commercial solution, but restricts the use of photovoltaic electricity to a few percent of total use at the most. If photovoltaic panels are to be used on rooftops for residential use day and night, good and cheap storage is a necessity. Nowadays lead acid batteries are used for this purpose, because they are the only cheap ones available. They have been developed for an entirely different purpose, however, have relatively low energy densities and resist deep discharge. In recent years we have been developing stationary zinc-bromine batteries for this purpose. These have high theoretical energy densities, deep discharge is no problem, and in principle they can be made very cheap. There are many other problems, however, which we try to solve and which will be discussed. (author)

19499 Performance and characteristics of inverters in remote and stand-alone applications. Bower, W. (Sandia National Labs., Albuquerque, NM (USA)); Phillips, S.; Schalles, F. pp. 1671 of Twentieth IEEE photovoltaic specialists conference, 1988. IEEE Service Center, Piscataway, NJ (1988). DOE Contract AC04-76DP00789. (CONF-880965–: 20. IEEE photovoltaic specialists conference, Las Vegas, NV (USA), 26-30 Sep 1988).

The performance and characteristics of inverters and ac loads for remote and stand-alone photovoltaic applications have been evaluated. The results of these evaluations are summarized. The compatibility and performance of the inverters and the loads are also presented with emphasis on total system efficiency and performance. The results show a critical need for minimum inverter specifications, categorizations of inverters, and guidelines for selection and use in the varied stand-along applications. Techniques for making efficiency measurements and evaluation of the ac load performance are discussed. Recommended specification guidelines and inverter categorizations are discussed.

19500 Solar simulation: Problems and solutions. . Emery, K. (Solar Energy Research Inst., Golden, CO (USA)); Myers, D.; Rummel, S. pp. 1671 of Twentieth IEEE photovoltaic specialists conference, 1988. IEEE Service Center, Piscataway, NJ (1988). DOE Contract AC02-83CH10093. (CONF-880965–: 20. IEEE photovoltaic specialists conference, Las Vegas, NV (USA), 26-30 Sep 1988).

Solar simulators are an integral part of any laboratory involved in photovoltaics (PV). This paper quantifies the effects of bulb aging, reflections off the simulator optics and fixturing, spectral irradiance, and variations in temporal and spatial characteristics of solar simulators on PV device performance. As the distance between the integrating optics or bulb decreases the spatial nonuniformity parallel and perpendicular to the test plane increases. A short focal length increases the possibility for an artificial increase in the measured current. The study quantifies the effect on the spectral irradiance and the spectral mismatch error for different bulb types, different bulbs of the same type, bulb age, bulb voltage, and distance from the bulb to the test plane.

19501 Performance modeling of lead-acid batteries in photovoltaic applications. Chamberlin, J.L. (Sandia National Labs., Albuquerque, NM (USA)). pp. 1671 of Twentieth IEEE photovoltaic specialists conference, 1988. IEEE Service Center, Piscataway, NJ (1988). DOE Contract AC04-76DP00789. (CONF-880965–: 20. IEEE photovoltaic specialists conference, Las Vegas, NV (USA), 26-30 Sep 1988).

The modeling of photovoltaic (PV) systems requires accurate descriptions of the performance of the system's individual subsystems and their interrelationships. For stand-alone application simulations, this requires an effective model of the energy storage subsystem, which generally consists of a lead-acid battery and its associated charge controller. A test of five lead-acid batteries of four generic types was conducted to determine the effectiveness of the energy storage subsystem's model used in Sandia's PV systems' simulation code PVFORM. While PVFORM accurately represented an adequately charged battery operating in a system with little excess array energy, considerable care was required in establishing the model's user-defined input parameters to describe the more typical performance of a battery when used with a controller that does not maximize the array's utilization. Causes for this poorer-than-expected battery performance are presented along with their impact on both system design and performance modeling.

1407 Solar Thermal Power Systems

Refer also to citation(s) 19515

19502 (SAND–89-1582C) **Measuring flow properties of wicks for heat pipe solar receivers.** Adkins, D.R.; Moss, T. Sandia National Labs., Albuquerque, NM (USA). [1990]. 12p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC04-76DP00789. (CONF-900449–1: ASME international solar energy conference, Miami, FL (USA), 1-4 Apr 1990). Order Number DE89016537. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A program is currently under way to develop liquid-metal heat pipes that can transfer energy from the focal point of a parabolic solar concentrator to the heater tubes of one or more Stirling

engines. To design high performance wicks for heat-pipe solar receivers, it is necessary to have an accurate assessment of the wick's properties. Procedures for measuring the flow properties of wicks before and after fabrication processes take place are presented in this paper. These testing procedures provide a useful method of determining the validity of a wick design before full-scale testing is attempted. 13 refs., 7 figs., 4 tabs.

19503 (SAND–89-2360C) **Evaluation of thermal cycling creep-fatigue damage for a molten salt receiver.** Grossman, J.W.; Jones, W.B.; Veers, P.S. Sandia National Labs., Albuquerque, NM (USA). [1990]. 13p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC04-76DP00789. (CONF-900449–3: ASME international solar energy conference, Miami, FL (USA), 1-4 Apr 1990). Order Number DE90002907. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A molten salt cavity receiver was solar tested at Sandia National Laboratories during a year-long test program. Upon completion of testing, an analysis was performed to determine the effect of thermal cycling on the receiver. The results indicate a substantial fatigue damage accumulation for the receiver when the relatively short test time is considered. This paper describes the methodology used to analyze the cycling, the results as they pertain to this receiver, and how they affect future receiver design. 8 refs., 4 figs.

19504 (SAND–89-2772C) **Test results from a full-scale sodium reflux pool-boiler solar receiver.** Moreno, J.B.; Andraka, C.E.; Diver, R.B.; Ginn, W.C.; Dudley, V.; Rawlinson, K.S. Sandia National Labs., Albuquerque, NM (USA). [1990]. 8p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC04-76DP00789. (CONF-900449–4: ASME international solar energy conference, Miami, FL (USA), 1-4 Apr 1990). Order Number DE90003577. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A sodium reflux pool-boiler solar receiver has been tested on a nominal 75-kW_t parabolic-dish concentrator. The purpose was to demonstrate the feasibility of reflux-receiver technology for application to Stirling-engine dish-electric systems. In this application, pool boilers (and more generally liquid-metal reflux receivers) have a number of advantages over directly-illuminated tube receivers. The advantages, to be discussed, include more uniform temperature, which results in longer lifetime and higher temperature available to the engine. 17 refs., 10 figs.

19505 (SAND–89-2870C) **An overview of advanced central receiver concepts.** Chavez, J.M. Sandia National Labs., Albuquerque, NM (USA). [1990]. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900394–2: 1990 national symposium of the Society of Mexican-American Engineers and Scientists (MAES), Albuquerque, NM (USA), 28-31 Mar 1990). Order Number DE90006808. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Sandia National Laboratories is investigating advanced central receiver concepts as part of the US Department of Energy solar thermal research program. In the last 12 years many studies and test programs have been carried out to develop and demonstrate the viability of central receiver power plants using tube-receivers with molten-nitrate-salt and steam. These receivers are currently the state-of-the-art. However, studies of advanced receiver concepts, such as the molten nitrate salt direct absorption receivers and volumetric air receivers, have shown their potential to be simple, cheaper, and have better performance than conventional tube receivers. In order to make central receivers economically competitive these advanced receiver concepts are being investigated. In a direct absorption receiver, the heat-absorbing fluid (a blackened molten nitrate salt) flows in a thin, wavy film down a flat, vertical panel (rather than through tubes) and absorbs the concentrated solar flux directly. The volumetric air receiver design uses a porous absorber, on which the solar energy is concentrated. Air flows through the absorber, convectively transferring energy from the absorber to the air. In this paper, the concepts, advantages, status, and test results of the salt-in-tube receiver, direct absorption receiver, and the volumetric receiver are discussed. 17 refs., 7 figs.

19506 (SERI/TR–253-3438) **Direct absorption receiver: Final technical report.** Bohn, M.S.; Carasso, M. Solar Energy Research Inst., Golden, CO (USA). Dec 1989. 124p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Order Number DE90000311. Available from NTIS, PC A06/MF A01 - OSTI.

This report describes research on several technical issues associated with the molten-salt direct absorption receiver concept. In particular, we consider the hydrodynamic stability of a long, liquid film, the ejection of droplets from the film, the convective and radiative heat-transfer mechanisms within the film and between the film and the support surface, and the stability of the liquid film with respect to thermocapillary breakdown in the presence of high flux and temperature gradients. The research showed that very small droplets originate from the bursting of turbulent eddies on the liquid surface and larger droplets begin to be ejected where the wave growth begins. The rate of droplet ejection increases exponentially along the flow length. Measuring the convective heat transfer between the nitrate salt film and the support surface showed that very high convective heat-transfer coefficients result, indicating that adding a dopant to darken the salt film may not be needed. These coefficients can be predicted reliably with existing heat-transfer correlations. Using a dimensionless scaling law, we found that the film should not be susceptible to thermocapillary breakdown; however, additional data at high Reynold numbers are needed to verify this. 38 refs., 31 figs., 4 tab.

1408 Ocean Energy Systems

19507 (SERI/TP–254-3619) **Experiments on oxygen desorption from surface warm seawater under open-cycle ocean thermal energy conversion (OC-OTEC) conditions.** Pesaran, A.A. Solar Energy Research Inst., Golden, CO (USA). Dec 1989. 8p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. (CONF-900449–8: ASME international solar energy conference, Miami, FL (USA), 1-4 Apr 1990). Order Number DE90000308. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper reports the results of scoping deaeration experiments conducted with warm surface seawater under open-cycle ocean thermal energy conversion (OC-OTEC). Concentrations of dissolved oxygen in seawater at three locations (in the supply water, water leaving a predeaerator, and discharge water from an evaporator) were measured and used to estimate oxygen desorption levels. The results suggest that 7% to 60% of dissolved oxygen in the supply water was desorbed from seawater in the predeaerator for pressures ranging from 9 to 35 kPa. Bubble injection in the upcomer increased the oxygen desorption rate by 20% to 60%. The dependence of oxygen desorption with flow rate could not be determined. The data also indicated that at typical OC-OTEC evaporator pressures when flashing occurred, 75% to 95% of dissolved oxygen was desorbed overall from the warm seawater. The uncertainty in results is larger than one would desire. These uncertainties are attributed to the uncertainties and difficulties in the dissolved oxygen measurements. Methods to improve the measurements for future gas desorption studies for warm surface and cold deep seawater under OC-OTEC conditions are recommended. 14 refs., 5 figs., 2 tabs.

19508 Progress in Claude-cycle ocean thermal energy conversion (OTEC) research. Bharathan, D. (Solar Energy Research Inst., Golden, CO (USA)). pp. 750 of Proceedings of the eighth international conference on offshore mechanics and Arctic engineering. 1989. Chung, J.S.; Ellinas, C.P.; Natvig, B.J.; Wardenier, J.; Penny, T.R. American Society of Mechanical Engineers, New York, NY (1989). (CONF-890325–: 8. international conference on offshore mechanics and arctic engineering, The Hague (Netherlands), 19-23 Mar 1989).

In this paper an overview of the direct-contact heat- and mass-transfer phenomena of importance in ocean thermal energy conversion (OTEC) is presented with particular emphasis on OC-OTEC systems. Also included is a historical review of OTEC developments in the past century and a comparison of open- and closed-cycle thermodynamics. Finally, results of system analyses, showing the effect of plant size on cost and the near-term potential

of using OTEC for combined power production and desalination systems are discussed.

1409 Solar Thermal Utilization

Refer also to citation(s) 19809

19509 (DOE/CE/15325–T4) **Intermittent Solar Ammonia Absorption Cycle (ISAAC) refrigeration for lesser developed countries: Final report, April 23, 1987–October 22, 1989.** Erickson, D.C. Energy Concepts Co., Annapolis, MD (USA). 6 Feb 1990. 4p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG01-87CE15325. Order Number DE90006700. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Intermittent Solar Ammonia Absorption Cycle (ISAAC) refrigerator is a solar thermal technology which provides low cost, efficient, reliable ice-making to areas without ready access to electricity. An ISAAC refrigeration system consists of a compound parabolic solar collector, two pressure vessels, a condenser, a cold box or refrigerated space, and simple connective piping – no moving parts or electrical components. Most parts are simple construction or plumbing grade materials, locally available in many remote areas. This technology has numerous potential benefits in lesser developed countries both by providing a cheap, reliable source of ice, and, since manufacture requires only semi-skilled labor, a source of employment to the local economy. Applications include vaccine storage for health care clinics; fish, meat, and dairy product storage; and personal consumption. Importantly, this technology increases the quality of life for people in lesser developed countries without depleting fossil fuel resources or increasing the release of greenhouse gases such as CO_2 and chlorofluorocarbons.

19510 (DOE/CH/10093–63) **Solar buildings program summary: Volume 2, Research summaries, fiscal year 1989.** Solar Energy Research Inst., Golden, CO (USA). Jan 1990. 47p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Order Number DE89009478. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Solar Buildings Program Summary is a two-volume reference set describing the technological advances and future research and development (R&D) directions of the Solar Buildings Technology Program for FY 1989 (October 1, 1988, through September 30, 1989). Volume II: Research Summaries, consists mainly of detailed descriptions of the various R&D activities performed by the national laboratories and their subcontractors from industry, academia, and nonprofit research institutions. This summary is divided into three main sections. Following the introduction, the first section includes the individual contract descriptions, grouped by directing organization and project area/task. A list of current publications is presented in the second section. The publications are listed alphabetically. The third section of this document contains a list of subcontractors, including the page numbers of the applicable contract descriptions.

19511 (DOE/SF/16306–T2) **Development and improvement of self-pumping boiling collector solar hot water storage system, June 1987–May 1988, in Colorado State University Solar House 3.** Davidson, J.H.; Walker, H.A.; Loef, G.O.G. Colorado State Univ., Fort Collins, CO (USA). Solar Energy Applications Lab. Nov 1988. 102p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG03-86SF16306. (SAN–16306-9). Order Number DE90007187. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The results of an experimental study of a pilot scale passive solar hot water heating system utilizing a boiling collector are presented. This work was supported by the US Department of Energy under grant No. FG03-86SF16306. The self-pumping system was designed and built in 1986. Heating season performance of the initial system during the winter of 1986-87 confirmed the viability of the design concept. This report details the continued experimental study of an improved self-pumping system during the period from June 1987 through May 1988. The system alternates between two modes of operation. During the run cycle, vapor pressure drives the evaporated refrigerant downward from the collector to the condenser. Once a preset quantity of refrigerant is condensed, vapor pressure is again used to force the return of the condensate to the collector during the pump cycle. The pilot system is optionally configured to operate with a mechanical pump. Daily operating characteristics and seasonal performance are discussed. The loss in thermal efficiency due to the use of vapor pressure to return liquid refrigerant to the collector is assessed by comparing self-pumping and mechanical-pumping operation. Daily thermal efficiency of the self-pumping system is relatively low as compared to fully developed commercial domestic solar hot water systems; however, mid-day cycle efficiencies are 40 to 50 percent. It is anticipated that daily efficiencies may be improved to the point that the self-pumping system will be an attractive alternative to more conventional sensible heat systems. Performance of the self-pumping system is strongly influenced by transient thermal losses. Refinement of the system design, including individual components, is required to reduce losses and improve performance. 21 refs., 27 figs., 2 tabs.

19512 (IE-MOEI–88/0100, pp. 54-55) **The Sun Town project - Swedish plans for the biggest seasonal storage plant in the world.** Jilar, T. (Chalmers Univ. of Tech., Building Services Engineering Dept., Gothenburg, (Sweden)). Ministry of Energy and Infrastructure, Jerusalem (Israel). Jun 1988. (CONF-880609–: Energy 88: 2. International congress and exhibition on energy, Tiberias (Israel), 5-10 Jun 1988). In *Energy 88. The 2nd international congress and exhibition on energy. Abstracts.* Available from COSTI P.O.B 20125, TEL-AVIV 61201.

Abstract only.

The aim of a recently completed techno-economic study was to present a feasible system concept for solar heating of all the buildings in Kungalv, Sweden. The four existing Swedish solar heating plants which use seasonal heat storage operate on different design principles, to test the development potential of different systems, and the experience gained from them was used in planning the Kungalv plant. District heating technology is well advanced in Sweden and its combination with large-scale solar heating technology will be of very wide applicability. About 100-150 plants of the Kungalv size would cover about 10% of Sweden's energy requirements for space heating and domestic hot water. In Kungalv about 50% of the total building space will be heated by the central solar plant, which will provide 56 GWh annually for 6,000 inhabitants and 115,000 m^2 of commercial, municipal and industrial buildings. The preliminary plant design involves 126,000 m^2 of high-temperature, flat-plate solar collectors and 396,000 m^3 of waterfilled rock caverns for seasonal heat storage. The aim is for solar energy to provide 75% of the required heating and fossil fuels the rest. The calculated cost of heat from the plant is SEK 0.35 per kWh, which rises to SEK 0.42 per kWh when the district heating network is included. The solar heat concept is currently less competitive than existing individual oil-burning plants, but anticipated governmental restrictions on air pollution may improve the competitive position of solar heating. (RP)

19513 (SERI/TP–253-3614) **Radiative transport models for solar thermal receiver/reactors.** Bohn, M.S.; Mehos, M.S. Solar Energy Research Inst., Golden, CO (USA). Dec 1989. 8p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. (CONF-900449–7: ASME international solar energy conference, Miami, FL (USA), 1-4 Apr 1990). Order Number DE90000303. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Modeling the behavior of solar-driven chemical reactors requires detailed knowledge of the absorbed solar flux throughout the calculation domain. Radiative transport models, which determine the radiative intensity field and absorbed solar flux, are discussed in this paper with special attention given to particular needs for the application of solar thermal receiver/reactors. The geometry of interest is an axisymmetric cylinder with a specified intensity field at one end, diffuse reflection at boundaries, and containing a participating medium. Participating media are of interest because receiver/reactors are expected to have one or more zones containing small particles or monoliths acting as absorbers or catalyst supports, either of which will absorb, emit, and scatter radiation. A general discussion of modeling techniques is given, followed by a more complete discussion of three models – the two-flux, discrete

ordinate, and the Monte Carlo methods. The methods are compared with published benchmark solutions for simplified geometries – the infinite cylinder and plane slab – and for geometries more closely related to receiver/reactors. Conclusions are drawn regarding the applicability of the techniques to general receiver/reactor models considering accuracy, ease of implementation, ease of interfacing with solution techniques for the other conservation equations, and numerical efficiency. 23 refs., 6 figs., 2 tabs.

1410 Solar Collectors and Concentrators

Refer also to citation(s) 19504

19514 (SAND–89-1500C) **Status of stretched-membrane heliostats.** Alpert, D.J.; Houser, R.M.; Heckes, A.A. Sandia National Labs., Albuquerque, NM (USA). [1990]. 13p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC04-76DP00789. (CONF-900449–2: ASME international solar energy conference, Miami, FL (USA), 1-4 Apr 1990). Order Number DE90000801. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Since the early 1980s, Sandia National Laboratories has been developing stretched-membrane heliostats for solar central receiver power plants. They differ from conventional glass-mirror heliostats in that the optical surface is a stretched membrane – a thin metal foil stretched over both sides of a large diameter ring. The reflective surface is provided by either a silvered-acrylic film or thin glass mirrors attached to the front membrane. Heliostats with single 14-m diameter (150 m^2) stretched-membrane reflectors have been designed. Because of their simplicity and light weight, stretched-membrane heliostats are expected to cost up to one-third less than conventional glass-mirror designs. Two generations of 50-m^2 prototype stretched-membrane mirror modules have been built and evaluated at Sandia's Central Receiver Test Facility in Albuquerque, NM. They demonstrated that the optical performance of membrane heliostats rivals that of glass-mirror heliostats. The durability of the silvered-acrylic reflective film has improved so that a lifetime of at least 5 years is likely; methods of replacing the film in the field are being investigated. Sandia recently initiated the final phase of development: the design of fully integrated, market-ready heliostats. Field tests of these heliostats are planned to begin in FY90. 17 refs., 6 figs.

1420 Heat Storage

Refer also to citation(s) 19510

19515 (SAND–89-2955C) **An economic analysis of a quad-panel Direct Absorption Receiver for a commercial-scale central receiver power plant.** Kolb, G.J.; Chavez, J.M. Sandia National Labs., Albuquerque, NM (USA). [1990]. 18p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC04-76DP00789. (CONF-900449–9: ASME international solar energy conference, Miami, FL (USA), 1-4 Apr 1990). Order Number DE90005959. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Direct Absorption Receiver (DAR) concept was proposed in the mid-1970s as an alternative advanced receiver concept to simplify and reduce the cost of solar central receiver systems. Rather than flowing through tubes exposed to the concentrated solar flux, the heat absorbing fluid (molten nitrate salt) would flow in a thin film down a flat, nearly vertical panel and absorb the flux directly. Potential advantages of the DAR over conventional tubular designs include a substantially simplified design, improved thermal performance, increased reliability and operating life, as well as reduced capital and operating costs. However, before commercial-scale designs can be realized, a method for controlling droplet ejection from the panel must be developed. In this paper, we present a new DAR design, which has the potential to control these droplets. The design employs four flat panels that are sloped backwards 5 degrees, wind spoilers, and air curtains. A systems analysis is presented indicating that the levelized-energy cost of the quad geometry should be very similar to cylindrical geometry that was originally proposed for the DAR concept. 19 refs., 5 figs., 3 tabs.

15 GEOTHERMAL ENERGY

1501 Resources and Availability

Refer also to citation(s) 19523, 19685

19516 (AIST–8904-1) **Japan's Sunshine Project. 1988 Annual summary of geothermal energy R and D.** Agency of Industrial Science and Technology, Tokyo (Japan). Apr 1989. 218p. (In Japanese). Order Number DE90753041. Available from NTIS (US Sales Only), PC A10/MF A01.

An outline of 1988 annual summary of geothermal energy R and D was described. As for exploration technology; confirmation of prospecting techniques and regional resources assessments were conducted at Sengan and Kurikoma areas, and researches on the exploration and assessment technologies of fractured-type geothermal reservoir were carried out at Yuzawa, Akita Prefecture. Nation-wide geothermal resources assessment was performed using volumetric algorithm. On heat extraction technology; applicability of new drill bit was investigated, furthermore, studies on the downhole coaxial heat exchanger system were conducted. Erosion-corrosion damage of materials in two phase flow was examined, and the study on development of excellent geothermal materials was carried out. As for hot dry rock power generating technology; a heat extraction test was done at Hijiori field in Yamagata Prefecture, fracturing and heat extraction mechanisms of hot dry rock by hydraulic fracturing were examined, and estimation of thermal production rate was done by circulation tests. On the technology for multipurpose utilization of energy and environmental preservation, techniques to recover useful minerals from geothermal brine were investigated. In order to promote the rational developments, comprehensive analysis system to extract promising areas was studied, and confirmation study of the effectiveness of prospecting techniques was done. As for the development of the binary cycle generation plant; 10 MW class power plant, down-hole pump, hot water injection and lost circulation techniques were investigated. Artificial reservoir and fracture mapping were studied for the development of hot dry rock power generation. 6 refs., 74 figs., 18 tabs.

19517 (AIST–8904-2) **Japan's Sunshine Project. 1988 Annual summary of geothermal energy R and D.** Agency of Industrial Science and Technology, Tokyo (Japan). Apr 1989. 215p. Order Number DE90753042. Available from NTIS (US Sales Only), PC A10/MF A01.

An outline of 1988 annual summary of geothermal energy R and D was described. As for exploration technology; confirmation of prospecting techniques and regional resources assessments were conducted at Sengan and Kurikoma areas, and researches on the exploration and assessment technologies of fractured-type geothermal reservoir were carried out at Yuzawa, Akita Prefecture. Nation-wide geothermal resources assessment was performed using volumetric algorithm. On heat extraction technology; applicability of new drill bit was investigated, furthermore, studies on the downhole coaxial heat exchanger system were conducted. Erosion-corrosion damage of materials in two phase flow was examined, and the study on development of excellent geothermal materials was carried out. As for hot dry rock power generating technology; a heat extraction test was done at Hijiori field in Yamagata Prefecture, fracturing and heat extraction mechanisms of hot dry rock by hydraulic fracturing were examined, and estimation of thermal production rate was done by circulation tests. On the technology for multipurpose utilization of energy and environmental preservation, techniques to recover useful minerals from geothermal brine were investigated. In order to promote the rational developments, comprehensive analysis system to extract promising areas was studied, and confirmation study of the effectiveness of prospecting techniques was done. As for the development of the binary cycle generation plant; 10 MW class power plant, down-hole pump, hot water injection and lost circulation techniques were investigated. Artificial reservoir and fracture mapping were studied for the development of hot dry rock power generation. 6 refs., 72 figs., 18 tabs.

19518 (EPRI-GS–6380, pp. 3-10) **The DOE geothermal R and D program - Positioning geothermal technology for a**

decade of expansion. Mock, J.E. (Department of Energy, Washington, DC (USA)); Ford, D.G. Electric Power Research Inst., Palo Alto, CA (USA). Jun 1989. (CONF-8706162–: 11. EPRI geothermal conference and workshop: basis for expansion, Oakland, CA (USA), 23-25 Jun 1987). In *Proceedings: Eleventh EPRI geothermal conference and workshop.* Order Number DE90004377. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Current estimates indicate that the demand for electric energy in the US may grow substantially over the coming decade. It is this period of growth that the US geothermal industry is looking toward as a stimulus to expansion of geothermal energy development. The DOE geothermal R and D program is working to overcome the major technological barriers to increased utilization of our nation's hydrothermal and advanced forms of geothermal energy. The near-term hydrothermal R&D activities are reviewed in the context of the program's long-term goals and objectives.

19519 (EPRI-GS–6380, pp. 23-27) **EPRI geothermal program.** Roberts, V.W. Electric Power Research Inst., Palo Alto, CA (USA). Jun 1989. (CONF-8706162–: 11. EPRI geothermal conference and workshop: basis for expansion, Oakland, CA (USA), 23-25 Jun 1987). In *Proceedings: Eleventh EPRI geothermal conference and workshop.* Order Number DE90004377. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

In its role as the research arm of the electric utility industry the Institute's mission is to provide leadership and innovation in science and technology, with the objective of assisting the utility industry to furnish the highest value energy services to its customers. The Institute plans to accomplish this mission by creating, integrating and interpreting scientific and technical information, by accelerating the commercial availability of products and systems that are responsive to the needs of the industry and the public in general, and by providing technical support to member organizations related to planning, procurement, operation, and maintenance of the electricity supply system.

1502 Geology and Hydrology of Geothermal Systems

Refer also to citation(s) 19257, 19516, 19517

1503 Geothermal Exploration and Exploration Technology

Refer also to citation(s) 19516, 19517

1504 Legislation and Regulations

Refer also to citation(s) 19520

1505 Economic, Industrial, and Business Aspects

19520 (EPRI-GS–6380, pp. 237) **Utility-grade resources.** Elliott, L.T. (Chevron Resources Company, San Francisco, CA (USA)). Electric Power Research Inst., Palo Alto, CA (USA). Jun 1989. (CONF-8706162–: 11. EPRI geothermal conference and workshop: basis for expansion, Oakland, CA (USA), 23-25 Jun 1987). In *Proceedings: Eleventh EPRI geothermal conference and workshop.* Order Number DE90004377. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

In order to develop a resource of utility-grade (i.e., capable of commercial electric power generation) a resource company needs to know that the costs of exploration, assessment, testing and development can be recovered from the sale of heat or electricity. The resource developer will have to bear the risk that more wells may be needed to supply the power plant. Unless the developer has reason to think that a price high enough to recover the costs can be obtained from the sale of the product, he will not develop the resource and the utility will not have the option of geothermal power generation. A bid system where the price of the electricity generated will be set by bidding among competing sources in a future year would introduce a high level of risk to developers and could preclude their proceeding to develop the option. A discussion on these items is summarized.

1508 Geothermal Power Plants

Refer also to citation(s) 19520, 19528

19521 (EPRI-GS–6380, pp. 43-50) **EPRI wellhead power system projects.** Hughes, E.E. Electric Power Research Inst., Palo Alto, CA (USA). Jun 1989. (CONF-8706162–: 11. EPRI geothermal conference and workshop: basis for expansion, Oakland, CA (USA), 23-25 Jun 1987). In *Proceedings: Eleventh EPRI geothermal conference and workshop.* Order Number DE90004377. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

EPRI's subprogram on geothermal wellhead power systems includes studies of resources, wells, and power conversion cycles and equipment. Current and recently completed projects in these areas are summarized in this paper. Field experiments and test programs are also summarized. These include upstream hydrogen sulfide removal, a gas/geothermal hybrid power system, and field data on radon as an in situ tracer in geothermal reservoirs. One major design effort is in progress. It is the design of a modular wellhead binary power system for use by utilities as the first unit on any new geothermal field in the 300 to 450°F temperature range. This standardized power system would also be selected when 3- to 8-MWe increments of expansion would best meet needs for capacity addition, resource evaluation or increased experience with a power conversion system operating at a site.

19522 (EPRI-GS–6380, pp. 59-63) **Hybrid cycle experiment at Pleasant Bayou.** Campbell, R.G. (The Ben Holt Co., Pasadena, CA (USA)). Electric Power Research Inst., Palo Alto, CA (USA). Jun 1989. (CONF-8706162–: 11. EPRI geothermal conference and workshop: basis for expansion, Oakland, CA (USA), 23-25 Jun 1987). In *Proceedings: Eleventh EPRI geothermal conference and workshop.* Order Number DE90004377. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Under contract to EPRI, The Ben Holt Co. has refurbished and procured equipment to be used to demonstrate the hybrid cycle for electricity production from a geopressured well. Hybrid power systems that combine both gas and geothermal heat as input for power generation can produce more than 15 percent more electricity than the same amount of fuel and geothermal fluid used in separate power plants. The hybrid concept can also reduce the risk and cost of developing hydrothermal resources for power generation. For geopressured resource development, the hybrid cycle is the preferred means of energy production when electricity prices are relatively higher than gas prices. Because no field test of this concept has been performed, EPRI and the US Department of Energy (DOE) are jointly sponsoring a program to build and test a gas/geothermal hybrid at the Pleasant Bayou geopressured well in Texas.

19523 (EPRI-GS–6380, pp. 117-120) **EPRI geothermal project overview.** Berning, J.L. Electric Power Research Inst., Palo Alto, CA (USA). Jun 1989. (CONF-8706162–: 11. EPRI geothermal conference and workshop: basis for expansion, Oakland, CA (USA), 23-25 Jun 1987). In *Proceedings: Eleventh EPRI geothermal conference and workshop.* Order Number DE90004377. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

EPRI has been supporting the development of moderate-temperature hydrothermal reservoirs since 1974. Successful development of binary-cycle technology similar to the Heber Binary Project and Flexible wellhead systems could almost double the amount of energy available from these moderate temperature resources. EPRI continues to support the development of binary-cycle technology with research studies, field experiments, and equipment design efforts, along with direct technical and financial participation.

19524 (EPRI-GS–6380, pp. 161-171) **Automatic on line mechanical cleaning system for condensers and heat exchangers.** Grande, M. (Northern California Power Agency (NCPA), Healdsburg (USA)); Someah, K. Electric Power Research Inst., Palo Alto,

CA (USA). Jun 1989. (CONF-8706162–: 11. EPRI geothermal conference and workshop: basis for expansion, Oakland, CA (USA), 23-25 Jun 1987). In *Proceedings: Eleventh EPRI geothermal conference and workshop.* Order Number DE90004377. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The on-line cleaning system for condensers and heat exchangers provides a positive means for automatic cleaning on a continuous basis while plant remains on stream and in its full operating condition. Condenser tube fouling contributes up to 50% of the total condenser tube heat transfer resistance. The penalties and the costs associated with the operation of a fouled condenser can include increased turbine hear rate and back pressure, increased operating and maintenance costs, reduced performance and power generation output, increased outages, and loss of plant availability. Foulants such as slime, bacterial matrix, algae, silt, scale, corrosion products, mud, sludge, etc., adhere to the heat transfer surfaces and gradually build on. They reduce efficiency of the best designed condenser/heat exchangers, induce localized corrosion of the condenser tubes, and eventually force a shutdown of the unit for manual cleaning. The problem could still exist even when using the most sophisticated water treatment available today. In this paper the various types of cleaning systems to reduce fouling will be discussed. The Northern California Power Agency's experience will be used to demonstrate the actual operating and maintenance savings associated with installing an on-line cleaning system at their geothermal power plants.

19525 (EPRI-GS–6380, pp. 185-194) **Concept-trainer/Analyzer development for the CCPA No. 1 Coldwater Creek Geothermal Power Plant.** Crouse, D.C. (Engineering Systems and Sciences Corporation, Solana Beach, CA (USA)); Greenlee, T.L.; Prideaux, D. Electric Power Research Inst., Palo Alto, CA (USA). Jun 1989. (CONF-8706162–: 11. EPRI geothermal conference and workshop: basis for expansion, Oakland, CA (USA), 23-25 Jun 1987). In *Proceedings: Eleventh EPRI geothermal conference and workshop.* Order Number DE90004377. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

A PC-based, fully interactive, Concept-trainer/Analyzer has been developed for the Coldwater Creek Geothermal Power Plant scheduled to begin commercial operation in April of 1987. This development by the Engineering Sciences and Systems Corporation (ESSCOR) was funded by the Central California Power Agency No. 1 (CCPA No. 1). The Concept-trainer/Analyzer is the first known PC-based interactive computer model developed for a dry-steam geothermal plant. The need for such a model arose out of consideration for the parallel unit operation and water inventory constraints which were unique to this geothermal site as well as the need to familiarize operators with the new plant configuration and Distributed Control System (DCS) technology. The Coldwater Creek Geothermal Power Plant is located at the north end of the Geysers KGRA approximately 15 miles east of Cloverdale, California. Construction on the power plant began in July of 1985 and the plant is now approximately 70% complete. The plant consists of two independent, 65 megawatt, two-flow turbine generators which receive steam from a common 48 inch main steam line. The plant will be manned 24 hours per day by two operators who will operate all equipment for both units from a central control room via a computer based distributed control system (DCS) using six (6) PC keyboards and video display monitors.

19526 (EPRI-GS–6380, pp. 219-234) **Validation results for a PC-based binary-cycle geothermal power plant stimulator/analyzer.** Greenlee, T.L. (Engineering Systems and Sciences Corporation, Solana Beach, CA (USA)); Crouse, D.C. Electric Power Research Inst., Palo Alto, CA (USA). Jun 1989. (CONF-8706162–: 11. EPRI geothermal conference and workshop: basis for expansion, Oakland, CA (USA), 23-25 Jun 1987). In *Proceedings: Eleventh EPRI geothermal conference and workshop.* Order Number DE90004377. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

A Binary-Cycle Geothermal Power Plant Simulator/Analyzer has been developed for use on today's personal computers. The simulator/analyzer, as developed, can be used for (1) Engineering analyses of static/dynamic performance and design trade-offs, (2) Operator training and operating procedure evaluation, and (3) Binary cycle technology demonstration. Simulator/analyzer development was funded by EPRI under Research Project 2195-07. The simulator/analyzer development and usage options are documented in a three volume report from EPRI. Volume One [1] is an executive summary that details project motivation, technical approach, simulator/analyzer scope, user interaction options, and required software/hardware. Volume Two [2] is a detailed description of project results. It emphasizes the model development procedure used to arrive at the required ordinary non-linear differential equations and elaborates on the graphic displays that a user can access. A user-programmer guide, Volume Three [3], that illustrates how to run the simulator is available with the simulator/analyzer software. The programmer guide details all component model development by indicating key assumptions and equations.

19527 (EPRI-GS–6380, pp. 241-243) **Comments on basis for expansion and report on discussion of decisions for next units.** Wischow, R.P. (Pacific Gas and Electric Company, San Francisco, CA (USA)). Electric Power Research Inst., Palo Alto, CA (USA). Jun 1989. (CONF-8706162–: 11. EPRI geothermal conference and workshop: basis for expansion, Oakland, CA (USA), 23-25 Jun 1987). In *Proceedings: Eleventh EPRI geothermal conference and workshop.* Order Number DE90004377. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The future expansion of the geothermal generating capacity by PG and E at The Geysers will be controlled by two major factors: first, the need for additional generation capacity, and second, optimal utilization of this finite and depletable geothermal resource. The planned expansion currently is one unit under development and two units in the preliminary planning phase. They also have several improvement projects which have begun or are planned.

1509 Geothermal Engineering

Refer also to citation(s) 19516, 19517, 19521, 19522, 19524, 19525, 19526, 19527

19528 (EPRI-GS–6380, pp. 239) **Database for operating units.** Nelson, T.T. (San Diego Gas and Electric Company, CA (USA)). Electric Power Research Inst., Palo Alto, CA (USA). Jun 1989. (CONF-8706162–: 11. EPRI geothermal conference and workshop: basis for expansion, Oakland, CA (USA), 23-25 Jun 1987). In *Proceedings: Eleventh EPRI geothermal conference and workshop.* Order Number DE90004377. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

To echo a theme heard several times during past sessions, the geothermal industry is in the early stages of a maturing industry. Much of the needed infrastructure for the industry is already in place, unlike some of the other emerging energy technologies. However, unlike the past, much of the recent power plant development has been by third parties and not the utilities. Consequently, much of the information generated by these third party plants is not as freely available as the data from utility-owned plants. The concern is one of keeping future utility geothermal power plant builders from reinventing the wheel. The two most likely organizations to shoulder this task are EPRI and DOE, since much of what these organizations are currently doing in their geothermal program1s is along these lines. The discussion group concluded that the good news in this are is that a system to preserve the data is already in place. Utility-owned power plants already report into the NERC/GADS system, and a set of geothermal based outage cause codes have already been developed. The bad news is that none of the third party geothermal plants are reporting into the system. Possible reasons for not reporting is the data is considered proprietary, the data is too costly or troublesome to collect, or no one has ever asked them for the data.

1520 Geothermal Data and Theory

19529 Spatial and temporal scales of local equilibrium in dynamic fluid-rock systems. Knapp, R.B. (Lawrence Livermore National Laboratory, CA (USA)). *Geochimica et Cosmochimica Acta (USA),* 53(8): 1955-1964 (Aug 1989).

The assumption of local equilibria (LEQ) is common when calculating the consequences of chemical interactions between a flowing

fluid and host rock. LEQ is a good approximation if an initial disequilibrium condition relaxes to an equilibrium state over a distance and time period that is less than the spatial and temporal scales-of-interest. These scales-of-interest depend on the particular problem under investigation and include the hundreds of meters scale for field investigations, the sub-meter scale for laboratory investigations and the sub-crystal scale. An equation representing the scale-of-interest and describing advective, diffusive and dispersive transport coupled with irreversible heterogeneous reaction is derived and analytically solved for a single component (silica), monomineralic (quartz), one-dimensional system. Typically, $t_{eq} \approx 1$ year and $l_{eq} \approx 10$ m for sedimentary basins; $t_{eq} \approx 3$ days and $l_{eq} \approx 10$ mm for host rocks in magma-hydrothermal systems; $t_{eq} \approx 10$ hours and $l_{eq} = 250$ μm for regional metamorphic environments; $t_{eq} \approx 1$ year and $l_{eq} \approx 100$ m for injection wells; $t_{eq} \approx 700$ years and $l_{eq} \approx 75$ km for laboratory core flow experiments. These values depend on the specifics of each environment and can vary over orders of magnitudes. LEQ is a good approximation if t_{eq} and l_{eq} are less than the scales-of-interest. This analysis, though quantitative, is only approximate because it does not include the effects of competing heterogeneous reactions. These effects result in over-estimation of t_{eq} and l_{eq} for low temperatures silicate environments and underestimation of t_{eq} and l_{eq} for high temperature environments.

17 WIND ENERGY

Refer also to citation(s) 19458

1706 Wind Energy Engineering

19530 (ILR-Mitt.–215(1988)) **Constructional limits of multi-blade wind turbines with individual flapping. Final report.** Maurer, J. Technische Univ. Berlin (Germany, F.R.). Inst. fuer Luft- und Raumfahrt. 1988. 202p. (In German). Contract ERP 2565. Order Number DE90753301. Available from NTIS (US Sales Only), PC A10/MF A01.

Rigid blades in a wind rotor will incur high bending momenta near the blade root, while flapping wings will totally remove the bending momentum. Experimental rotors of the Aerospace Institutes of this type, with diameters of 3.5 and 7 meters, were extremely reliable and smooth-running. The report discusses the feasibility of economically more favourable rotors with diameters of 15 meters and more. (BR).

19531 (SERI/TP–257-3662) **PC-based PCM [Pulse Code Modulation] telemetry data reduction system hardware.** Simms, D.A.; Butterfield, C.P. Solar Energy Research Inst., Golden, CO (USA). Feb 1990. 11p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Order Number DE90000316. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Solar Energy Research Institute's (SERI) Wind Research Program is using pulse code modulation (PCM) telemetry systems to study horizontal-axis wind turbines. SERI has developed a low-cost PC-based PCM data acquisition system to facilitate quick PCM data analysis in the field. The SERI PC-PCM system consists of AT-compatible hardware boards for decoding and combining PCM data streams and DOS software for control and management of data acquisition. Up to four boards can be installed in a single PC, providing the capability to combine data from four PCM streams direct to disk or memory. This paper describes the SERI PC-PCM system hardware, focusing on the practicality of PC-based PCM data reduction. A related paper highlights our comprehensive PCM data management software program which can be used in conjunction with this hardware to provide full "quick-look" data processing and display. The PC-PCM hardware boards support a subset of the Inter-Range Instrumentation Group (IRIG) PCM standard, designed to synchronize and decommutate NRZ or Bi-Phase L PCM streams in the range of 1 to 800 Kbits/sec at 8 to 12 bits per word and 2 to 64 words per frame. Multiple PCM streams (at various rates) can be combined and interleaved into a contiguous digital time series. Maximum data throughput depends on characteristics of the PC hardware, such as CPU rate and disk access speed. 7 refs., 6 figs., 4 tabs.

19532 (STEV-VIND–89-25) **Investigation of electric power pulsations from a 2 MW wind turbine generator.** Nordqvist, P. (Chalmers Univ. of Tech., Goeteborg (SE). Dept. of Electrical Machines and Power Electronics). Statens Energiverk, Stockholm (Sweden). Jul 1989. 9p. Project STEV-506-258. (CONF-890717–3: European wind energy conference and exhibition, Glasgow (UK), 10-13 Jul 1989). Order Number DE90748567. Available from NTIS (US Sales Only), PC A02/MF A01.

The Swedish State Power Board has since 1983 operated a 2 MW wind turbine generator on request of the Swedish National Energy Administration. The wind turbine is situated on the cape Naesudden, which is located in the southern part of the Gotland island. During the measurements, which have been done on the Naesudden wind turbine generator since 1983, oscillations on power delivered to the network has been noted at times. It can be determined from a frequency spectrum that there is a dominating frequency at 0.83 Hz. The second and third multiple of this frequency are also easy to recognize from the measured frequency spectrum and the half value of 0.83 Hz can also be observed in this spectra. The amplitude of the power variations during these occasions is approximately about 30-40 % of the nominal value. For example one maximum top to top value of the power pulsations has been measured to 1.25 MW. In this paper this phenomenon will be discussed and the theory to make a computer model will be presented. The theory shows that there is a possibility that a torque pulsation can cause power oscillations on a network-generator-capacitor system, when the torque pulsation frequency is the same as the undamped natural frequency of the network-generator-capacitor system. If the damping factor for the system is large enough the result will be that the torque pulsation will not cause any problems with oscillations on the power fed to the grid.

20 FOSSIL-FUELED POWER PLANTS

2001 Power Plants and Power Generation

Refer also to citation(s) 19204, 19226, 19228, 19233, 19234, 19238, 19239, 19240, 19241, 19243, 19244, 19245, 19246, 19249, 19250, 19540, 19729, 19845, 20828

19533 (CONF-8903197–1) **Electric generation with natural gas.** Long, G.M. Institute of Gas Technology, Chicago, IL (USA). [1989]. 14p. Sponsored by Institute of Gas Technology. From Symposium on Asian natural gas - a new era; Singapore (Singapore); 6-9 Mar 1989. Available from OSTI; IGT, 3424 South State Street, Chicago, IL 60616.

This paper discusses the benefits of natural gas use in electric generating stations. Modes of gas use in converting existing plants are listed and are followed by some precautions to take in avoiding problems. Dual-fuel plants are described as to their benefits when full natural gas supply is not always feasible. Addition of electric generating capacity with gas turbine-driven units is discussed. Cogeneration and utilization of waste heat are described. 5 refs., 5 figs.

19534 (EPRI-GS–6620-Vol.1) **Compressed-air energy storage using hard-rock geology: Test facility and results: Volume 1, Test results: Final report.** Pellin, J. (Societe Electrique de l'Our S.A., Luxembourg (Luxembourg)). Electric Power Research Inst., Palo Alto, CA (USA); Societe Electrique de l'Our S.A., Luxembourg (Luxembourg). c Jan 1990. 654p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This report presents results of the first part of a two-part investigation regarding hard-rock CAES plants. It is a detailed presentation of field data acquired to better understand the "champagne effect" and provide inputs to the second part of the investigation, which conducted model development, calibration, and prediction regarding the "champagne effect." The field data was obtained at SEO's Urschmitt 18-bar test facility, which was suitably modified so that a test program could be developed and carried out over an approximately two-year period. The overall approach proved to be viable, i.e., develop a crude mathematical model of the phenomenon, then formulate a test program based on model

calibration needs and hardware capabilities, acquire field data, and iteratively improve the model until it satisfactorily matched experimental observation. In relation to calibration of the computer model, a host of data was obtained for different test configurations, flow rates, and saturation levels. All this data was made available to the model-calibration contractor for evaluation, model calibration, and transient response predictions. A separate report on this model and its predictions is being issued concurrently under EPRI project RP 2488-3.

19535 (EPRI-GS–6635) **Proceedings: 1988 EPRI heat-rate improvement conference.** Hoornaert, P.G. (Sargent and Lundy, Chicago, IL (USA)). Electric Power Research Inst., Palo Alto, CA (USA); Sargent and Lundy, Chicago, IL (USA). c Jan 1990. 963p. Sponsored by Electric Power Research Institute. (CONF-8805358–: 1988 EPRI heat-rate improvement conference, Richmond, VA (USA), 10-12 May 1988). Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

An EPRI-sponsored conference to address heat rate improvement of existing fossil fuel plants was held in Richmond, Virginia, on May 10–12, 1988. The conference was attended by 426 representatives from utilities and consulting firms. The meeting was organized around several themes: utility experience with heat rate improvement, including monitoring and overall programs; technology development to assist heat rate improvements; and testing to make accurate evaluations of heat rate both for monitoring performance and for evaluating the changes resulting from modified equipment and practices. Group discussions were held on several topics: Instrumentation and Performance Monitoring; Computer Application; Coal Quality Measurements; Boiler Performance Testing and Optimization; Turbine Monitoring and Diagnostics; and Feedwater Heaters and Condensers. Individual projects are processed separately for the databases.

19536 (EPRI-GS–6673) **R and D plans for advanced computer and control technologies: Volume 1, Executive summary: Final report.** Sopocy, D.M. (Sargent and Lundy, Chicago, IL (USA)). Electric Power Research Inst., Palo Alto, CA (USA); Sargent and Lundy, Chicago, IL (USA). c Feb 1990. 80p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This volume is the Executive Summary of the EPRI R&D plans in three related areas of fossil-fired power plant design and operation: controls and instrumentation; expert systems; and automation and simulators. Volumes 2, 3, and 4 of this series individually discuss these three research areas. Both short- and long-term R&D needs of the utility industry are addressed in these plans. 14 refs., 15 figs., 3 tabs.

19537 (EPRI-GS–6704) **Sodium/sulfur battery storage: integrated generation portfolio analysis and commercialization strategy: Final report.** Bos, P.B.; Borja, D.B. Electric Power Research Inst., Palo Alto, CA (USA); Polydyne, Inc., San Mateo, CA (USA). c Feb 1990. 107p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This report summarizes the work performed by Polydyne, Inc. for the Electric Power Research Institute (EPRI) under Contract RP 128-15. The objectives of this study are (1) to assess both the near- and long-term market potential and penetration of sodium-sulphur batteries for electric utility storage and load leveling; and (2) based upon this analysis, to develop a feasible strategy for commercialization of this technology. This report documents the results of an integrated commercialization analysis of sodium-sulphur batteries for electric utility storage applications. The analysis represents an integration of market, economic, risk, and financial considerations, culminating in a dynamic market penetration potential for sodium-sulphur battery storage plants. This potential is derived over time under conditions of uncertainty as part of an overall portfolio approach to generation planning. The resulting commercialization strategy involves forward-pricing of the first twelve 100-MWh sodium- sulphur battery storage plants in high-value markets at an average price reflecting learning costs and portfolio considerations. This forward price is commensurate with the portfolio valuation or risk-premium of the sodium-sulphur battery in high-value utility markets. Subsequent to these first twelve plants, the marginal cost of sodium-sulphur battery storage plants is projected to become increasingly attractive in comparison to other alternatives for peaking and intermediate load applications as a result of further production learning and technological innovation cost reductions. Based upon generation portfolio considerations, the potential portfolio market for mature sodium-sulphur batteries for electric utility applications was assessed to be one-third of the peaking capacity (approximately 5% of the total US installed generation capacity), or 45 GW by 1990 to 60 GW by the year 2030. 30 refs., 35 figs., 13 tabs.

19538 (EPRI-GS/ER–6665) **A coal gasification–combined-cycle power plant with methanol storage: Final report.** Eustis, R.H. (Stanford Univ., CA (USA). Dept. of Mechanical Engineering); Paffenbarger, J.A. Electric Power Research Inst., Palo Alto, CA (USA); Stanford Univ., CA (USA). Dept. of Mechanical Engineering. c Feb 1990. 227p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This study examines the design and performance of a coal gasification combined-cycle power plant with an integrated facility for producing and storing methanol (GCC/methanol power plant). The methanol is produced at a steady rate and is burned in the combined-cycle to generate additional power during periods of peak electrical demand. The GCC/methanol plant takes advantage of electricity generation and energy storage in one coal-based facility. It is of potential interest to electric utilities seeking to meet increasing baseload and peak electrical demand on their systems, and is somewhat analogous to other energy storage facilities such as pumped hydroelectric or compressed air energy storage plants. The plant configuration is determine by means of an economic screening study considering capital and fuel costs over a range of cycling duties (load factors). Estimated levelized electricity production costs indicate that a GCC/methanol plant could be of economic interest as premium fuel prices increase relative to coal. The plant could potentially be of interest for meeting daily peak demands for periods of eight hours or less. The conceptual plant configuration is developed in greater detail using a Texaco gasifier and a Lurgi methanol synthesis plant. Plant performance is estimated at peak and baseload output levels using the ASPEN process analysis computer program. An acceptable use of by-product flows from the methanol plant was developed. No unusual design or operation problems were identified. 87 refs., 41 figs., 20 tabs.

19539 (IE-MOEI–88/0100, pp. 26) **Measuring the efficiency of fossil fuel fired thermal power plants - an international comparison.** Bernstein, M.A. (Univ. of Pennsylvania, Energy Center, Philadelphia, USA); Feldman, S.L.; Schinnar, A.P. Ministry of Energy and Infrastructure, Jerusalem (Israel). Jun 1988. (CONF-880609–: Energy 88: 2. International congress and exhibition on energy, Tiberias (Israel), 5-10 Jun 1988). In *Energy 88. The 2nd international congress and exhibition on energy. Abstracts.* Available from COSTI P.O.B 20125, TEL-AVIV 61201.

Abstract only.

The efficiencies of fossil fueled power plants and the electric utilities which they feed are compared, for the USA and for 8 Asian countries, including Japan, South Korea and Taiwan. Plant and utility operations are discussed, including the relationship between management decisions and technical limitations which is involved in utility performance evaluation. The Best Practice Frontier methodology, which was used to analyze utility productivity, is discussed. Performance analysis showed that Japan's utilities were efficient and had consistent operations, that Taiwan's efficiency increased to 1980 but decreased later with a shift from fossil fuels, and that Korea consistently increased its efficiency over 10 years. The average efficiencies of US utilities were below those of Northeast Asian countries, especially Taiwan and Japan, but comparable with those of Southeast Asian countries. (RP)

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Refer also to citation(s) 19196, 19197, 19226, 19229, 19242, 19247, 19248, 20038

19540 (DOE/FE–0157) **Comprehensive report to Congress: Clean Coal Technology program: Demonstration of coal reburning for cyclone boiler NO_x control: A project proposed by: Babcock & Wilcox Company.** USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Office of Clean Coal Technology. Feb 1990. 36p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90008111. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A Program Opportunity Notice (PON) was issued by the Department of Energy (DOE) in February 1988, soliciting proposals to demonstrate technologies capable of being commercialized in the 1990's that are more cost effective than current technologies and capable of achieving significant reduction of sulfur dioxide (SO_2) and/or nitrogen oxides (NO_x) emissions from existing coal burning facilities. One of the proposals selected is the Babcox & Wilcox Company (B&W) project that will demonstrate an innovative technology to reduce nitrogen oxide emissions from coal-fired cyclone boilers. This technology consists of burning a portion of the coal fuel in an oxygen-deficient atmosphere in a reburning zone. To destroy the nitrogen oxides formed in the main combustion zone, the reburning is located above the combustion zone of the boiler. The project will be conducted at the 100 megawatt (MWe) coal-fired Nelson Dewey Station Unit No. 2, owned by Wisconsin Power & Light Company (WP&L), located in Cassville, Wisconsin. The WP&L plant is presently in commercial operation. The intent of this project is to demonstrate the technical and economic viability of retrofitting coal reburning on a cyclone boiler that is representative of those constructed before New Source Performance Standards (NSPS) became effective. 6 figs., 1 tab.

19541 (DOE/FE–0158) **Demonstration of innovative applications of technology for the CT-121 FGD [flue gas desulfurization] process: A project proposed by Southern Company Services, Inc.: Comprehensive report to Congress Clean Coal Technology Program.** USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Office of Clean Coal Technology. Feb 1990. 39p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90008110. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A Program Opportunity Notice (PON) was issued by the Department of Energy (DOE) in February 1988, soliciting proposals to demonstrate technologies capable of commercialization in the 1990s, that are more cost effective than current technologies and capable of achieving significant reductions in sulfur dioxide (SO_2) and/or nitrogen oxides (NO_x) emissions from existing coal burning facilities, particularly those that contribute to transboundary and interstate pollution. One of the sixteen projects selected for funding proposed by Southern Company Services, Inc. (SCS), is a wet flue gas desulfurization (FGD) process that removes sulfur dioxide (SO_2) and particulates, produces a salable by-product gypsum and eliminates solid waste production. This process removes SO_2 and particulate matter using a unique, limestone-based scrubber called the Jet Bubbling Reactor (JBR). The purpose of this ICCT project is to demonstrate the process on high-ash and high-sulfur, US coal using several design modifications that will reduce the estimated cost of the present CT-121 process applications by 23% for power plant retrofit applications and 50% for new power plant installations. This project will be performed at the Georgia Power Company's Plant Yates, Unit Number 1, located about 40 miles southwest of Atlanta. The plant is presently in commercial operation.

19542 (DOE/FE–0159) **Comprehensive report to Congress Clean Coal Technology Program: PFBC [pressurized fluidized-bed combustion] Utility Demonstration Project.** USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Office of Clean Coal Technology. Feb 1990. 27p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90008094. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A Program Opportunity Notice (PON) was issued by the Department of Energy (DOE) in February 1988, soliciting proposals to demonstrate technologies that were capable of being commercialized in the 1990's, more cost effective than current technologies, and capable of achieving significant reduction of sulfur dioxide (SO_2) and/or nitrogen oxides (NO_x) emissions from existing coal-burning facilities, particularly those that contribute to transboundary and interstate pollution. A proposal by American Electric Power Service Corporation (AEPSC) was one of those selected for negotiation. AEPSC requested financial assistance from DOE for a project to demonstrate pressurized fluidized-bed combustion (PFBC) technology in a large-scale repowering application at the AEP Philip Sporn power plant. The Sporn plant is a utility-scale, commercially operating power plant located in New Haven, West Virginia. The demonstration objective will be accomplished by repowering two commercially operating 150-MWe pulverized coal-fired electric generating units of early 1950's vintage with a single PFBC module which will be operated in a combined-cycle mode. The proposed system will remove sulfur and minimize nitrogen oxide formation during the combustion process. The planned generating capacity of the plant will be at least 330 MWe, making it the world's largest PFBC facility proposed to date. Unique features of the proposed plant are that it will be commercially dispatched on a demand basis and that it will include, within the boiler, provisions for steam reheat to accommodate the requirements of the existing steam turbines. 8 figs., 4 tabs.

19543 (ESC-WR–89-20) **Model KORAM.** Van Wees, F.G.H. Stichting Energieonderzoek Centrum Nederland, Petten (Netherlands). Energie Studie Centrum. Dec 1989. 57p. (In Dutch). Project ECN/ESC 7054. Available from Netherlands Energy Research Foundation ECN, P.O. Box 1, 1755 ZG Petten, Netherlands.

A model has been developed to describe the complexity of costs with regard to production, market and, if necessary, storage of coal residues. Attention is paid to the set-up and operation in developing the so-called KORAM-model. The model can support governmental policy in presenting a quantitative insight in flows of coal residues and estimated positive or negative residuals as well as processing costs. The model can be applicated on a PC using the software program Symphony. This project deals with three types of fly ash as result of electric power generation. Data are presented on the production of the fly ashes, capacities of the power plants, sales and processing costs for the years 1988-1998 and 1999-2008. The appendices give the manual to use the KORAM-model, figures on the KORAM-R module (production of residues) and the KORAM-model, and results of calculations on variants of the reference case. 4 apps.

19544 (VTT-SYMP–103, pp. 344) **Purification of flue gases by catalytic and adsorption processes.** Huuska, M. (Technical Research Centre of Finland, Espoo (Finland). Chemical Laboratory); Hjerp, P. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). 1989. (CONF-8806445–Vol.2: Seminar on non-waste technology, Espoo (Finland), 20-23 Jun 1988). In *Non-waste technology: Volume 2.* Order Number DE90748455. Available from NTIS (US Sales Only), PC A16/MF A01.

Abstract only. NITROGEN OXIDES/adsorption; NITROGEN OXIDES/catalysis; ADSORPTION; CATALYSIS; FLUE GAS; COMBUSTION PRODUCTS; AIR POLLUTION CONTROL; ALUMINIUM COMPOUNDS

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Refer also to citation(s) 19729

21 NUCLEAR POWER PLANTS

Refer also to citation(s) 21083

19545 (NUREG–0020-Vol.14-No.1) **Licensed operating reactors: Status summary report, data as of 12-31-89: Volume 14, No. 1, January 1990.** Nuclear Regulatory Commission, Washington, DC (USA). Office of Information Resources Management. Feb 1990. 503p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A22/MF A01 - GPO; OSTI, INIS.

The Operating Units Status Report - Licensed Operating Reactors provides data on the operation of nuclear units as timely and accurately as possible. This information is collected by the Office of Information Resources Management from the Headquarters staff of NRC's Office of Enforcement (OE), from NRC's Regional Offices, and from utilities. The three sections of the report are: monthly

highlights and statistics for commercial operating units, and errata from previously reported data; a compilation of detailed information on each unit, provided by NRC's Regional Offices, OE Headquarters and the utilities; and an appendix for miscellaneous information such as spent fuel storage capability, reactor-years of experience and non-power reactors in the US. It is hoped the report is helpful to all agencies and individuals interested in maintaining an awareness of the US energy situation as a whole.

2101 Power Reactors, Nonbreeding, Light-Water Moderated, Boiling Water Cooled

Refer also to citation(s) 19325, 19334, 19375, 19550, 19561, 19563, 19569, 19570, 19575, 19589, 19590, 19591, 19592, 19594, 19595, 19596, 19598, 19599, 19600, 19602, 19603, 19604, 19605, 19606, 19607, 19609, 19611, 19612, 19613, 20096

19546 (CONF-900403–7) **Mitigation of stress corrosion cracking of AISI 304 stainless steel in oxygenated water at 289°C by organic species at low concentration.** Kassner, T.F.; Ruther, W.E.; Soppet, W.K. Argonne National Lab., IL (USA). Oct 1989. 28p. Sponsored by Nuclear Regulatory Commission. DOE Contract W-31109-ENG-38. From Corrosion '90; Las Vegas, NV (USA); 23-27 Apr 1990. Order Number DE90005631. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In constant-extension-rate tests on sensitized AISI 304 stainless steel (SS) at 289°C, some organic substances (oxygen scavengers) in feedwater containing ~0.2 ppm dissolved oxygen decrease effluent oxygen concentration, electrochemical potential (ECP) of the steel, and stress corrosion cracking (SCC) susceptibility to very low levels. Other organic substances neither decrease oxygen concentration nor ECP of the steel significantly, but also mitigate SCC susceptibility relative to that in high-purity oxygenated water. The latter species apparently block active sites where cathodic reduction of oxygen occurs and thereby limit anodic dissolution of metal at the crack tip in a slip-dissolution mechanism of crack advance. In SCC tests on fracture-mechanics-type specimens under high-load-ratio, low-frequency cyclic loading conditions at 289°C, the organic inhibitors at a concentration of ~1.0 ppm stop crack growth in the sensitized steel, but are not effective in oxygenated water containing ionic impurities such as sulfate or chloride at the 0.1-ppm level. These results are consistent with the site blockage mechanism for different species that undergo cathodic reduction and control the rate of crack growth of the steel in the SCC tests. 39 refs., 5 figs., 4 tabs.

19547 (NUREG/CR–4744-Vol.3-No.1) **Long-term embrittlement of cast duplex stainless steels in LWR [light water reactor] systems: Semiannual report, October 1987–March 1988.** Chopra, O.K. (Argonne National Lab., IL (USA)); Chung, H.M. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; Argonne National Lab., IL (USA). Feb 1990. 50p. Sponsored by Nuclear Regulatory Commission. DOE Contract W-31109-ENG-38. (ANL–89/22-Vol.3-No.1). Available from NTIS, PC A04/MF A01 - GPO; OSTI; INIS.

This progress report summarizes work performed by Argonne National Laboratory on long-term embrittlement of cast duplex stainless steels in LWR systems during the six months from October 1987 to March 1988. A mechanistic understanding of the activation energy of aging is described on the basis of the results of microstructural characterization of various heats of Grades CF-3, CF-8, and CF-8M stainless steel that were used in aging studies at different laboratories. The kinetics of the spinodal decomposition of ferrite (i.e., the primary mechanism of aging embrittlement) appear to be strongly influenced by a synergistic effect of G-phase nucleation and growth. When the activation energies (ranging from 18 to 50 kcal/mole) were plotted as a function of the volume fraction of G phase produced during accelerated aging, a good correlation was obtained regardless of variations in grade, bulk chemical composition, and fabrication process. Spinodal-like decomposition of austenite in heats containing a relatively high level of Ni has also been investigated. Charpy-impact data for thermally aged cast stainless steel were analyzed to determine the kinetics and extent of embrittlement. The ferrite morphology had a strong effect on the extent of embrittlement, whereas the material composition influenced the kinetics of embrittlement. Results obtained from the present study of mechanical properties, and data of other investigators were analyzed to develop the procedure and correlations for predicting the kinetics and extent of embrittlement, under reactor operating conditions, from the material parameters. 31 refs., 30 figs., 1 tab.

2102 Power Reactors, Nonbreeding, Light-Water Moderated, Nonboiling Water Cooled

Refer also to citation(s) 19325, 19334, 19375, 19546, 19547, 19563, 19570, 19574, 19576, 19577, 19578, 19579, 19580, 19584, 19586, 19587, 19588, 19589, 19591, 19592, 19593, 19594, 19595, 19596, 19597, 19599, 19600, 19601, 19602, 19603, 19604, 19605, 19606, 19607, 19609, 19610, 19611, 19612, 19613, 20096, 20378

19548 (CNEN-DR–93/80) **Evaluation of the setpoints of the overtemperature DeltaT tripping function for Angra 1. PT.1.** Comissao Nacional de Energia Nuclear, Rio de Janeiro, RJ (Brazil). Dept. de Reatores. Dec 1980. 167p. (In Portuguese). Order Number DE90617837. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

This report is the first of two-part series that review the setpoints of the overtemperature DeltaT tripping functions for Angra I. These results, obtained with a modidied COBRA-IIIC computer program version, are for typical subchannels in steady state situation or during short-term transients (min-hrs). In order to study the consequences of some approximations, the analysis started from model for DNBR calculation with an inadequate subchannels and equivalent rods array. For the determination of DNBR=1.30 curves a more realistic array was used. The overtemperature DeltaT trip setpoints are conservatively below the DNBR=1.30 curves calculated in this part of the review. (author).

19549 (EPRI-NP–6698) **Analysis of zircaloy oxide thickness data from PWRs: Final report.** Sheppard, K.D. (Stoller (S.M.) Corp., Pleasantville, NY (USA)); Speyer, D.M.; Chan, Y.Y.; Franki, I.; Strasser, A.A. Electric Power Research Inst., Palo Alto, CA (USA); Stoller (S.M.) Corp., Pleasantville, NY (USA). c Feb 1990. 71p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Prior EPRI funded research (Project 1250-1) resulted in a set of Zircaloy waterside corrosion models. These models were based principally on KWU reactor data. The objective of this study was to evaluate the ability of the KWU corrosion models to predict available domestic USA data for all domestic PWR vendors in order to further validate the models and to provide a consistent basis to judge the corrosion data of the domestic plants. A methodology for analyzing the large amount of data was developed and implemented in a single channel model. This model includes the capability, by a method described herein, of accounting for open core related effects (crossflow) and the effect of the immediately adjacent fuel rods, guide tubes, etc., on the coolant conditions around the fuel rods that were measured for oxide thickness. Data from the Arkansas Unit #2 (ANO-2) Combustion Engineering (C-E), Oconee Units 1 and 2 built by Babcock & Wilcox (B&W), and the Trojan reactor built by Westinghouse (W) were used in this study. The corrosion models previously developed, and the present single channel model methodology, were able to predict the corrosion data quite well. The maximum corrosion thickness was on the order of 20 to 40 microns in all plants studied. 13 refs., 11 figs., 5 tabs.

19550 (INIS-XN–201) **Advanced water-cooled reactor technologies. Rationale, state of progress and outlook.** Anon. Nuclear Energy Agency, 75 - Paris (France). 1989. 102p. Order Number DE90617843. Available from NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS.

Eighty per cent of the world's power reactors are water cooled and moderated. Many improvements in their design and operation have been implemented since the first such reactor started commercial operation in 1957. This report addresses the safety, environmental and economic rationales for further improvements, as well as their relevance to currently operating water reactors.

19551 (KFK–4663) **HADA-2 (modified version of HADA). A FORTRAN-IV program for the thermohydraulic design of an advanced pressurized light water reactor with a tight fuel rod lattice.** Mori, T.; Cigarini, M.; Dalle Donne, M. Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Projektgruppe LWR-Sicherheit (PRS). Nov 1989. 124p. Order Number DE90753599. Available from NTIS (US Sales Only), PC A06/MF A01.

The FORTRAN-IV program HADA, which computes the thermohydraulic parameters for Advanced Pressurized Light Water Reactors with a tight fuel rod lattice, has been modified to extend its applicability. The new version can be applied to homogeneous reactors using grid spacers with an arbitrary linear heat rating or an arbitrary core height. This version is also applicable to an axially heterogeneous reactor (multiple stacked core) which has been designed in JAERI and is not based on the modern PWR plant of German design. For users of the program, the report describes the modifications and the input data in detail. Three sample runs demonstrate the usage of the program and the output. The provided and used solution algorithms are explained, in addition to the description of the physical background given in KfK-3453 and KfK-4148. The utility programs are described and an installation guide for the program system is listed. (orig.).

2103 Power Reactors, Nonbreeding, Graphite Moderated

Refer also to citation(s) 19334, 20029, 20259, 20348, 20359, 20364, 20365, 20376

2104 Power Reactors, Nonbreeding, Otherwise Moderated or Unmoderated

Refer also to citation(s) 19550

2105 Power Reactors, Breeding

Refer also to citation(s) 19555, 19563, 19589, 21096

19552 (CONF-900418–3) **An evaluation of LMR design options for reduction of sodium void worth.** Hill, R.N.; Khalil, H. Argonne National Lab., IL (USA). [1989]. 19p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From International conference on the physics of reactors: operation, design and computation; Marseilles (France); 23-26 Apr 1990. Order Number DE90003824. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In this study, we analyze the relationship between the sodium void worth (ρ_{NA}) and other important performance characteristics for various design options which reduce ρ_{NA}. Our objective was to identify a preferred design option for reducing ρ_{NA} based on an overall consideration of performance tradeoffs. The focus of this study is on core designs of recent interest in the US LMR program, i.e. designs in the 450 to 1200 MWt size range that make use of metal alloy fuel. A key objective of the LMR development program in the US has been to design cores that can passively avoid damage when the control rods fail to scram in response to postulated accident initiators (e.g. inadvertent reactivity insertion or loss of coolant flow). Analyses and experimental tests of such unprotected events have demonstrated that the physical properties of metallic fuel alloys and the neutronic feedback characteristics of metal-fueled cores can be exploited to obtain favorable relations among the power, power/flow, and inlet temperature coefficients of reactivity and, consequently, large margins to sodium boiling and fuel damage under accident conditions. Since the reactivity effects of sodium density variation during postulated accidents are effectively compensated by other feedback effects, reduction of the sodium void worth has not been a primary design objective for recent LMR concepts; relatively large values ($4 to $6) are predicted for current core designs. 23 refs., 11 figs.

2106 Power Reactors, Auxiliary, Mobile, Package, and Transportable

19553 (CEA-CONF–9851) **A preliminary assessment of reactor candidate technologies for a 20 kWe space nuclear Brayton nuclear.** Carre, F. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. d'Etudes Mecaniques et Thermiques); Proust, E.; Tilliette, Z.; Vrillon, B.; Keirle, P.; Chaudourne, S. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. d'Etudes Mecaniques et Thermiques. 1989. 6p. (CONF-890103–: 6. symposium on space nuclear power systems, Albuquerque, NM (USA), 9-12 Jan 1989). Order Number DE90752528. Available from NTIS (US Sales Only), PC A02/MF A01.

In 1983, a cooperative program between the French Centre National d'Etudes Spaciales (CNES) and the Commissariat a l'Energie Atomique (CEA) was initiated to investigate the possible development of 20 to 200 kWe Brayton nuclear space systems. After the completion of the preliminary design of a reference 200 kWe turboelectric power system known as ERATO in 1986 (Carre et al. 1987), a second 3-year study phase was initiated. The objective of this phase was to assess the various reactor candidate technologies and system design options for 20 kWe power level for meeting the projected electric needs of the first European space missions (Carre et al. 1988). This paper presents the results of the design studies of three reference design concepts of 20 kWe turboelectric power systems covering a wide range of reactor temperatures and relevant material and reactor design technologies. Additionally the critical technology issues of the candidate systems, and other criteria relevant to the space missions are identified. The participation of the French industry in the present design activity is so far restricted to predesign studies of crucial components such as the turbomachinery and the reactor control actuators, and integration studies of the power system into the Ariane V launcher.

19554 (CEA-CONF–9852) **Brayton cycle conversion system and temperature conditioning of small space nuclear reactors.** Tilliette, Z.P.; Carre, F.; Proust, E. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. d'Etudes Mecaniques et Thermiques. 1989. 4p. (CONF-890103–: 6. symposium on space nuclear power systems, Albuquerque, NM (USA), 9-12 Jan 1989). Order Number DE90752527. Available from NTIS (US Sales Only), PC A02/MF A01.

A companion paper (Carre et al. 1989) presented at this symposium gives an overview of the French preliminary studies on space nuclear power systems in progress within the framework of a three-year (1986-1989) program. Other papers (Proust et al. 1988, Tilliette et al. 1988, Tilliette IECEC 1988) supplement the information on this activity. Low power levels of about 20-KWe and both liquid metal- and gas-cooled reactors are concerned. The Brayton cycle is currently selected as the conversion subsystem. Critical issues like safety, reliability, radiation shielding and reactor concept and technology have to be addressed more and more carefully and relevant temperature conditions are crucial. It is shown in this paper that the Brayton cycle can offer a valuable flexibility which allows the desired thermal environment. For instance, it is possible to significantly decrease the reactor inlet temperature and consequently, also given an adequate design, to favourably put forward convenient solutions for the lateral and axial bottom reflector, the shadow shield, the control drums drives and safety rods actuators and penetrations as well as for the possibility of using efficient moderator materials like metal hydrides (ZrH or ^{7}LiH), which is worth being investigated as far as low power levels are concerned. Examples of Brayton cycle conversion subsystems and possible reactor arrangements are presented for both gas-cooled and liquid metal (NaK or Na)-cooled reactor heat sources. The study follows up the research described by Thilliette (1988, IECEC).

19555 (CONF-900418–4) **Analysis and evaluation of ZPPR [Zero Power Physics Reactor] critical experiments for a 100 kilowatt-electric space reactor.** McFarlane, H.F. (Argonne National Lab., Idaho Falls, ID (USA)); Collins, P.J.; Carpenter, S.G.; Olsen, D.N.; Smith, D.M.; Schaefer, R.W.; Doncals, R.A.; Andre, S.V.; Porter, C.A.; Cowan, C.L. Argonne National Lab., Idaho Falls, ID (USA). [1990]. 14p. Sponsored by U.S. DOE Nuclear Energy.

DOE Contract W-31109-ENG-38. From International conference on the physics of reactors: operation, design and computation; Marseilles (France); 23-26 Apr 1990. Order Number DE90005634. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

ZPPR critical experiments were used for physics testing the reactor design of the SP-100, a 100-kW thermoelectric LMR that is being developed to provide electrical power for space applications. These tests validated all key physics characteristics of the design, including the ultimate safety in the event of a launch or re-entry accident. Both the experiments and the analysis required the use of techniques not previously applied to fast reactor designs. A few significant discrepancies between the experimental and calculated results leave opportunities for further optimization. An initial investigation has been made into application of the ZPPR-20 results, along with those of other relevant integral data, to the SP-100 design. 13 refs., 5 figs., 7 tabs.

2107 Regulation and Licensing

Refer also to citation(s) 19572, 19587, 19588, 19609, 20464

19556 (NUREG–0040-Vol.13-No.4) **Licensee contractor and vendor inspection status report: Quarterly report, October 1989–December 1989.** Nuclear Regulatory Commission, Washington, DC (USA). Div. of Reactor Inspection and Safeguards. Jan 1990. 82p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A05/MF A01 - GPO; OSTI; INIS.

This periodical covers the results of inspections performed by the NRC's Vendor Inspection Branch that have been distributed to the inspected organizations during the period from October 1989 through December 1989.

19557 (NUREG–0750-Vol.30-No.4) **Nuclear Regulatory Commission issuances, October 1989: Volume 30, No. 4.** Nuclear Regulatory Commission, Washington, DC (USA). Div. of Freedom of Information and Publications Services. Oct 1989. 100p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A05/MF A01 - GPO; OSTI; INIS.

This report includes the issuances received during the specified period from the Commission (CLI), the Atomic Safety and Licensing Appeal Boards (ALAB), the Atomic Safety and Licensing Boards (LBP), the Administrative Law Judge (ALJ), the Directors' Decisions (DD), and the Denials of Petitions for Rulemaking (DPRM).

2108 Economics

Refer also to citation(s) 19565

22 NUCLEAR REACTOR TECHNOLOGY

2201 Theory and Calculation

Refer also to citation(s) 19555, 20088

2202 Components and Accessories

Refer also to citation(s) 19845, 19886, 20018, 20781

19558 (CEGB-RD-M–1779/RR89) **Damping of cylindrical structures subject to annular flow.** Hobson, D.E.; Dolding, M. Central Electricity Generating Board, Southampton (UK). Marchwood Engineering Labs. Jan 1989. VP Order Number DE90616308. Available from NTIS (US Sales Only), PC A04/MF A01 - OSTI; INIS.

In previous reports theoretical methods have been described for estimating the aerodynamic forces acting on cylinders vibrating laterally when surrounded by an annulus carrying high velocity gas. For a certain restricted set of geometries it is possible to predict whether a particular structure is stable or unstable and to determine the level of aerodynamic damping positive or negative due to the presence of the gas. This report describes experimental work which validates the computer program in which the theoretical methods are embodied; in particular the damping, inertial and decentralising forces acting on a cylinder in an annulus are measured and compared with theory over a range of frequencies from 0 to 25 Hz, and of Reynolds numbers from zero to 10^4. In addition a summary of simple relationships is provided which can be used to provide credible initial estimates of both the positive and negative damping of cylinders in a range of annular geometries. (author).

2203 Fuel Elements

19559 (PPA-AL–9) **Thermal neutron spectrum distribution in TRIGA fuels.** Gui Ah Auu (Unit Tenaga Nuklear, Bangi, Selangor (Malaysia)); Harasawa, Susumu; An, Shigehiro. Unit Tenaga Nuklear, Bangi, Selangor (Malaysia). 1989. 17p. (CONF-8905246–: 2. Asian symposium on research reactors (ASRR-II), Serpong (Indonesia), 23-25 May 1989). Order Number DE90617820. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The dependence of thermal neutron spectrum in TRIGA fuel cell on fuel temperature and TRIGA fuel types were studied using LIBP and THERMOS codes. Some characteristics of the TRIGA fuel including its prompt negative temperature coefficient of reactivity were explained using the results of the study. (author).

2204 Control Systems

Refer also to citation(s) 20207, 20344

19560 (BNL–43705) **Transient response of level instruments in a research reactor.** Cheng, Lap Y. Brookhaven National Lab., Upton, NY (USA). [1989]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. (CONF-900494–2: 1990 SCS Eastern multiconference, Nashville, TN (USA), 23-29 Apr 1990). Order Number DE90005572. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A numerical model has been developed to simulate the dynamics of water level instruments in a research nuclear reactor. A bubble device, with helium gas as the working fluid, is used to monitor liquid level by sensing the static head pressure due to the height of liquid in the reactor vessel. A finite-difference model is constructed to study the transient response of the water level instruments to pressure perturbations. The field equations which describe the hydraulics of the helium gas in the bubbler device are arranged in the form of a tridiagonal matrix and the field variables are solved at each time step by the Thomas algorithm. Simulation results indicate that the dynamic response of the helium gas depends mainly on the volume and the inertia of the gas in the level instrument tubings. The anomalies in the simulated level indication are attributed to the inherent lag in the level instrument due to the hydraulics of the system. 1 ref., 5 figs.

19561 (CONF-900464–3) **LQG/LTR [linear quadratic Gaussian with loop transfer recovery] robust control system design for a low-pressure feedwater heater train.** Murphy, G.V. (Tennessee Univ., Knoxville, TN (USA)); Bailey, J.M. Oak Ridge National Lab., TN (USA). [1990]. 9p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. From IEEE Southeastcon; New Orleans, LA (USA); 1-4 Apr 1990. Order Number DE90006144. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This paper uses the linear quadratic Gaussian with loop transfer recovery (LQG/LTR) control system design method to obtain a level control system for a low-pressure feedwater heater train. The control system performance and stability robustness are evaluated for a given set of system design specifications. The tools for analysis are the return ratio, return difference, and inverse return difference singular-value plots for a loop break at the plant output. 3 refs., 7 figs., 2 tabs.

19562 (IPEN-PUB–273) **PC-Reactor-core transient simulation code.** Nakata, H. Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo, SP (Brazil). Oct 1989. 26p. (In Portuguese). Order Number DE90617871. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

PC-REATOR, a reactor core transient simulation code has been developed for the real-time operator training on a IBM-PC microcomputer. The program presents capabilities for on-line exchange of the operating parameters during the transient simulation, by friendly keyboard instructions. The model is based on the point-kinetics approximation, with 2 delayed neutron percursors and up to 11 decay power generating groups. (author).

19563 (IWGFR–71) **Specialists' meeting on advanced controls for fast reactors.** Argonne National Lab., IL (USA); International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors. [1989]. 377p. DOE Contract W-31109-ENG-38. (CONF-890673–6: IWGFR specialists meeting on advanced controls for fast reactors, Argonne, IL (USA), 20-22 Jun 1989). Order Number DE90006470. Available from NTIS (US Sales Only), PC A17/MF A01 - OSTI.

The Specialists' Meeting on "Advanced Controls for Fast Reactors" was held in Argonne, Illinois, USA, from June 20 to 22, 1989. The meeting was sponsored by the International Atomic Energy Agency on the recommendation of the IAEA International Working Group on Fast Reactors and was hosted by Argonne National Laboratory and the US Department of Energy. It was attended by 20 participants and observers from Argentina, France, Germany, Japan, India, the USSR, the United Kingdom, the United States of America, and the IAEA. The purpose of the meeting was to provide an opportunity for participating countries to review and discuss their views on design and technology for advanced control in fast reactors. The following main topical areas were discussed by the participants: (1) overviews of national programs on approach to advanced control for fast reactors; (2) specialist papers on plant automation; (3) plant-system-design to facilitate control and safety; (4) advanced operator aids: sensor validation and diagnostics; (5) advanced operator aids: expert systems and advanced graphics; and (6) summary reports and agreement of recommendations. During the meeting papers were presented by the participants on behalf of their countries and organizations. Presentations were followed by open discussions on the subjects covered by the papers and summaries of the discussions were drafted. After the formal sessions were completed, a final discussion session was held and summaries, general conclusions and recommendations were approved by consensus. Each presentation has its own abstract.

19564 (Juel–2306) **Noise thermometry in industrial plants (detection, analysis and elimination of interfering signals).** Mueller, G. Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Zentrallabor fuer Elektronik; Technische Hochschule Aachen (Germany, F.R.). Aug 1989. 171p. (In German). Order Number DE90753302. Available from NTIS (US Sales Only), PC A08/MF A01.

With particular consideration of the needs of noise thermometry special averaging methods detecting interference signals in the time domain (signal averaging) and the frequency domain (FFT-spectra) were optimized. These methods were realized by digital signal processing. Methods of interference suppression 'in the signal' (blanking parts of the signal in the time or frequency domain) were optimized. If these methods do not deliver adequate results, measures modifying the plant itself become necessary. Examples are described. Based on these methods new concepts of noise thermometer measurements are realized. By means of these concepts detection of interferences, elimination and temperature measurement can be combined. Thus changes of the interfering environment, even during the temperature measurement, are recorded, mismeasurements can be avoided. The complexity of the equipment needed and the effectiveness of different varieties of detection-, elimination- and temperature measurement methods are discussed. The use of the described methods has been shown in industrial plants with high level interferences. The noise thermometer was installed in the AVR reactor and the Neckar reactor and a plant for high temperature applications. The measures to avoid coupling of interferences are described. Temperature measurements were successfully done. The accuracy obtained was better than 0.1%-0.5%, depending on the plant. (orig./HP).

2205 Environmental Aspects

Refer also to citation(s) 19334, 19418, 19576, 19577, 19614, 19639, 19656, 19666, 19678, 19730, 20310, 20311, 20312, 20313, 20314, 20315, 20316, 20317, 20318, 20319, 20320, 20321, 20322, 20358, 20364, 20365, 20378

19565 A sensitivity analysis of multicriteria choice-methods: An application on the basis of the optimal site selection for a nuclear power plant. . Hartog, J.A. (Erasmus Univ., Rotterdam (Netherlands)); Hinloopen, E.; Nijkamp, P. *Energy Economics (UK),* 11(4): 293-300 (Oct 1989).

Three classes of qualitative multicriteria methods are dealt with in this paper. An empirical problem, the choice of the best site for a nuclear power plant, is used to investigate the extent to which the results of the analysis are influenced by the choice of specific methods. The conclusion is that a certain sensitivity is unavoidable but that the final ranking of the alternatives - on the basis of a set of good methods -is nevertheless reasonably stable. (author).

2206 Research, Test, and Experimental Reactors

Refer also to citation(s) 19334, 19445, 19555, 19559, 19560, 19562, 19569, 21011, 21075

19566 (AECL–9515) **Slowpoke - its application to district heating.** Lynch, G.F. Atomic Energy of Canada Ltd., Chalk River, ON (Canada). Chalk River Nuclear Labs. Jul 1987. 8p. (CONF-870905–: 6. Pacific Basin nuclear conference, Beijing (China), 7-11 Sep 1987). Order Number DE90617870. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Over 25% of the primary energy consumption in most of the countries of the northern Pacific Basin is used to heat buildings. This represents an important opportunity for nuclear energy to significantly reduce the dependence on fossil fuels in an end-use application that is readily amenable to substitution. In a major departure from traditional nuclear power technology, Atomic Energy of Canada Limited has developed the SLOWPOKE Energy System - a 10 MWt nuclear heat source specially designed to satisfy the needs of local heating systems used by buildings and institutions. A prototype reactor has been constructed to verify in a very demonstrative way that the technical, economic and safety criteria for nuclear district heating systems can in fact be met.

19567 (ORNL/M–915) **Analysis of ORNL site temperature and humidity data.** Willis, B.E. (Tuskegee Univ., AL (USA)). Oak Ridge National Lab., TN (USA). Aug 1989. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90006729. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Advanced Neutron Source (ANS) is planned as a new state-of-the-art facility for neutron research and is currently undergoing conceptual design at the Oak Ridge National Laboratory (ORNL). The current concept calls for a nuclear research reactor with an operating power near 350 MW and extensive experiment and user support facilities. Analyses have been undertaken to determine an acceptable design basis wet-bulb temperature range for the facility. Comparisons are drawn with the design wet-bulb temperature previously used for the High Flux Isotope Reactor (HFIR), which is located on an adjacent site a Oak Ridge. This report explains the importance of wet-bulb temperature to the reactor cooling system performance, and describes the analysis of available meteorological data, and presents the results and the recommendations for a wet-bulb temperature range for use as a part of the plant design basis conditions. 1 ref., 6 figs.

2207 Plutonium and Isotope Production Reactors

Refer also to citation(s) 19582, 21076

2208 Propulsion Reactors

19568 (AD-A–214354/3/XAB) **Heating rates in a High-Energy Propulsion System (HEPS) Orbital Transfer Vehicle (OTV). Final report, June-August 1989.** Miller, R.L. Air Force

Astronautics Lab., Edwards AFB, CA (USA). Oct 1989. 27p. (AL-TR–89-056). Available from NTIS, PC A03/MF A01.

Rocket-propulsion systems that use nuclear-energy sources present unique challenges to the design, safety, and reliability of the concept. Since the vehicle and its components must operate in high radiation fields, nuclear heating and radiation effects must be determined and factored into the system design. This report analyzes the nuclear heating in a High-Energy Propulsion System (HEPS) Orbital Transfer Vehicle (OTV) nozzle. Using the FEMP2D (Finite Element, Multigroup, Pn, 2-Dimensional) code for an aluminum and carbon-carbon nozzle, it was determined that the heating contribution was found to be the significant source of heating for both materials. The overall heating rate in the aluminum nozzle (approx. 12 W/cc) was significantly higher than that found in the carbon-carbon nozzle (approx. 8 W/cc).

2209 Reactor Safety

Refer also to citation(s) 19552, 19555, 19556, 19557, 19560, 19563, 19632, 19634, 19640, 19643, 19655, 19659, 19675, 19693, 19709, 20210, 20259, 20348, 20359, 20376, 20437, 20464, 21011, 21096

19569 (ANSTO/E–685) **Molten fuel-coolant interactions resulting from power transients in aluminium plate/water moderated reactors.** Storr, G.J. Australian Nuclear Science and Technology Organisation, Lucas Heights (Australia). Aug 1989. 30p. Order Number DE90617646. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The behaviour of two reactors SL1 and SPERT D12, which underwent fast nuclear power transients prior to core destruction by a molten fuel-coolant interaction (MFCI) has been analysed and the results compared with measured data. The calculated spatial melt distribution and the mechanical work done during the events leads to high (approx 250 kJ/kg) conversion efficiencies for this type of interaction when compared with molten drop experiments. A simple model for the steam explosion, using static thermodynamic properties of high temperature and pressure steam is used to calculate the dynamics of the reactors following the MFCI. 26 refs., 5 figs., 5 tabs.

19570 (BIeV-R–66.849-1) **Specification of experiments on aerosol behaviour within a multi-compartment containment and on filtered venting systems. Final report.** Behrens, U.; Fischer, K.; Kanzleiter, T.; Ruppert, B. Battelle-Institut e.V., Frankfurt am Main (Germany, F.R.); Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). May 1988. 122p. (In German). Contract BMFT 1500 768. Available from Battelle-Institut e.V., Frankfurt am Main (Germany, F.R.). Available from Battelle-Institut e.V., Frankfurt am Main (Germany, F.R.).

To investigate the depletion behaviour of multi-component aerosols in a multi-compartment containment, a test matrix comprising 7 experiments in the 640 m^3 Battelle model containment was developed. As the test conditions and objectives have been changed as compared with previous DEMONA experiments (now: mlti-compartment geometry, inhomogeneous atmosphere, code verification), it was necessary to modify the test facility and to adapt the test instrumentation. To investigate the behaviour of filtered venting systems for partial containment depressurization as a measure to mitigate long-term overpressure failure caused by a core meltdown accident, a test facility and the necessary test instrumentation were designed. The test matrix comprises 9 experiments to be performed with an original metal fibre filter module as is used, e.g. in the Brokdorf reactor. (orig./HP).

19571 (BNL–43654) **Detection of leaks in a water-cooled generator stator bar using perfluorocarbon tracers: Final report.** Loss, W.M.; Dietz, R.N.; Senum, G.I. Brookhaven National Lab., Upton, NY (USA). Dec 1989. 23p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. Order Number DE90007355. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A generator stator bar with a suspected leak was removed from the ConEdison Ravenswood power plant and shipped to an independent laboratory for hydraulic pressure testing. The test failed to demonstrate the location and magnitude of leaks. The stator bar was subsequently investigated at Brookhaven's Tracer Technology Center. Pressurization with 3 ppM PMCP (perfluoromethylcyclopentane) in hydrogen as carrier gas revealed a leak close to the turbine end of the generator. The equivalent water leak rate was calculated to be about 1/2 mL per day at 30 psi water pressure. A series of tests was designed to first verify the existence of potential leaks and then to locate these leaks as accurately as possible. Enclosing the bar in a flexible hose, introducing nitrogen gas into the hose and analyzing the hose exhaust with Brookhaven's Dual Trap Analyzer successfully identified the existence of leaks. However, the technique failed to locate the approximation position of the suspected leaks. It was found that diffusion and the existence of a laminar flow regime inside the hose prevented the formation of uniform concentration levels and, hence, consistent readings. Successful leak pinpointing was accomplished by wrapping short sections of the bar in plastic bags. This approach with some suggested improvements is also recommended for future experiments with stator bars. 6 figs., 1 tab.

19572 (CONF-8910192–) **Second DOE natural phenomena hazards mitigation conference: Proceedings.** Lawrence Livermore National Lab., CA (USA). [1989]. 436p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-48. From 2. DOE natural phenomena hazards mitigation conference; Knoxville, TN (USA); 3-5 Oct 1989. Order Number DE90006928. Available from NTIS, PC A19/MF A01; OSTI; INIS; GPO Dep.

This conference has been organized into ten presentation sessions which include an overview of the DOE Natural Phenomena Guidelines, Seismic Analysis, Seismic Design, Modifying Existing Facilities, DOE Orders, Codes, and Standards (2 sessions), Seismic Hazard (2 sessions), and Probabilistic Risk Assessment (2 sessions). Two poster sessions were also included in the program to provide a different forum for communication of ideas. Over the past fourteen years, Lawrence Livermore National Laboratory, Nuclear Systems Safety Program, has been working with the US Department of Energy, Office of Safety Appraisals and their predecessors in the area of natural phenomena hazards. During this time we have developed seismic, extreme wind/tornado, and flood hazard models for DOE sites in the United States. Guidelines for designing and evaluating DOE facilities for natural phenomena have been developed and are in interim use throughout the DOE community. A series of state-of-the practice manuals have also been developed to aid the designers. All of this material is listed in the Natural Phenomena Hazards Bibliography included in these proceedings. This conference provides a mechanism to disseminate current information on natural phenomena hazards and their mitigation. It provides an opportunity to bring together members of the DOE community to discuss current projects, to share information, and to hear practicing members of the structural engineering community discuss their experiences from past natural phenomena, future trends, and any changes to building codes. Each paper or poster presented is included in these proceedings. We have also included material related to the luncheon and dinner talks.

19573 (EGG-EAST–8511) **Flow instability onset in tubes, channels, annuli, and rod bundles.** Duffey, R.B.; Hughes, E.D. EG and G Idaho, Inc., Idaho Falls, ID (USA). Nov 1989. 56p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90006970. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

A theoretical model for the onset of flow instability for vertical upflow and downflow of a boiling fluid in a constant pressure drop flow channel is developed. The model is based on the momentum and energy balance equations for these flows with an algebraic modeling of two-phase velocity-slip effects. Predictions of the model are tested against experimental data for heat flux, length, inlet subcooling, and exit fluid quality effects. The model predictions of the dependency of the minimum mass flux on these variables are in complete agreement with the trends of the data. The experimental data have been taken from round tube, rectangular channel, annulus, and rod bundle geometries, with vertical upflow and downflow, under both non-bulk boiling and net vapor generation conditions. The data collection given in the report appears to be

among the most complete available in the literature. The theoretical model results suggest two methods for correlating about limited ranges of operating state parameters for a fixed geometry. These correlating methods are given in the paper along with specific correlating lines for one of the methods. 30 refs., 12 figs., 2 tabs.

19574 (EGG-HFRU–8705) **Abnormal operating procedures for ATR [Advanced Test Reactor's] experiment loops.** Aufiick, J.L. EG and G Idaho, Inc., Idaho Falls, ID (USA). Sep 1989. 28p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90006960. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper outlines the background from the TMI accident which resulted in the definition and development of function-oriented procedures. It also explains how function-oriented procedures were applied in a task for the Advanced Test Reactor's (ATR) NR experiment loops. Human performance design discrepancies were identified for existing procedures, and were corrected by upgrading them according to current NRC and DOE standards. Finally, specific recommendations are made with respect to future ATR control room and loop improvements, as they relate to the revision of operating procedures within INEL's power reactor program. 8 refs., 4 figs.

19575 (EGG-M–88172) **Gamma-ray emission tomography examination of TMI-2 core samples.** Akers, D.W.; Hartwell, J.K. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1988]. 16p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-881024–23: TMI-2 accident materials behavior, plant technology and recovery, Washington, DC (USA), 30 Oct - 4 nov 1988). Order Number DE90006948. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

An examination method developed at the Idaho National Engineering Laboratory (INEL) is being used to determine the distribution of gamma-ray emitting radionuclides in samples in reactor fuel and prior molten materials. This paper presents the results of a gamma-ray emission tomographic examination performed on cross sections of samples of prior molten fuel material recovered from the TMI-2 reactor. The results indicate substantial relocation of fission products in the debris and the probable accumulation of specific radioactive species in various phases of the material. The observed behavior correlated with the results of microstructural examinations and elemental compositions obtained from SEM/WDX, electron microprobe, and radiochemical analyses. 5 refs., 9 figs.

19576 (EGG-M–88176) **TMI-2 fission product inventory estimates.** Akers, D.W. (EG and G Idaho, Inc., Idaho Falls, ID (USA)); Tolman, E.L.; Kuan, P.; Golden, D.W.; Nishio, M. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1988]. 17p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-881024–21: TMI-2 accident materials behavior, plant technology and recovery, Washington, DC (USA), 30 Oct - 4 nov 1988). Order Number DE90006961. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The purpose of this paper is to summarize the results through 1988 to estimate the post-accident inventory and distribution of selected radionuclides within the TMI-2 reactor system. Radionuclides for which best-estimate inventories are presented include: Krypton (^{85}Kr), Cesium (^{137}Cs), Iodine (^{129}I), Antimony (^{125}Sb), Strontium (^{90}Sr), Ruthenium (^{106}Ru), and Cerium (^{144}Ce). This inventory accounting includes all repositories in the TMI-2 reactor system. The principal repositories are the reactor building basement for cesium and iodine and the reactor vessel for all other radionuclides. 15 refs., 1 fig., 4 tabs.

19577 (EGG-M–88202) **Fission product behavior distribution in the TMI-2 reactor building.** McIsaac, C.V.; Kohli, R.; Denning, R.S.; Akers, D.W. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1988]. 21p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-881024–24: TMI-2 accident materials behavior, plant technology and recovery, Washington, DC (USA), 30 Oct - 4 nov 1988). Order Number DE90006963. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper summarizes the results of the examinations performed on samples from the reactor building surfaces and water and samples obtained from the reactor coolant system. The total quantities of fission products, fuel, and core material elements measured on the reactor building surfaces, basement water and sediment and on the reactor coolant system surfaces. These measurements show that significant amounts of the tritium (59%), radioiodine (33%) and cesium (47%) originally in the core at the time of the accident have relocated outside the reactor vessel. 14 refs., 1 tab.

19578 (EGG-M–88237) **Gamma-ray emission tomographic examinations of TMI-2 fuel debris.** Akers, D.W.; Hartwell, J.; Hobbins, R.R.; Makowitz, H. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1988]. 12p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-8806143–11: Nuclear reactor severe accident chemistry symposium, Toronto (Canada), 5-10 Jun 1988). Order Number DE90006985. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

An examination method developed at the Idaho National Engineering Laboratory (INEL) is being used to determine the distribution of gamma-ray emitting radionuclides in high density reactor fuel and prior molten materials. This paper presents the results of the gamma-ray emission tomographic examinations performed on samples of prior molten materials from the TMI-2 core and an evaluation of the materials chemistry, based on elemental and SEM/WDX examinations of the samples, that resulted in the observed fission product behavior. The sample examination of a metallurgical cross section from a large particle of prior molten fuel from the lower head of the reactor has been completed. The results indicate substantial relocation of fission products in the debris and the probable accumulation of some in various phases of the material. 4 refs., 7 figs., 1 tab.

19579 (EGG-M–88304) **TMI-2 core materials and fission product inventory.** Akers, D.W. (EG and G Idaho, Inc., Idaho Falls, ID (USA)); McCardell, R.K.; Russell, M.L.; Worku, G. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1988]. 22p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-8810244–4: 16. light water reactor safety conference, Washington, DC (USA), 24-28 Oct 1988). Order Number DE90007406. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; GPO Dep.

Examinations have been performed to characterize the distribution of core materials and fission products at the damaged Three Mile Island Unit 2 (TMI-2) reactor. The purpose of this paper is to summarize the current status of the core materials and fission product inventory evaluations at TMI-2 and to present results that may affect reactor source term issues. Principal subjects include the relocation of core materials out of the reactor vessel, the formation of complex, core material interaction products, cesium retention in prior molten material, and the retention of tellurium, antimony and ruthenium in association with core materials. Material examinations have now been performed on samples from throughout the reactor building and vessel to provide definition to the end state core configuration and materials behavior. These examination results have been used to evaluate the redistribution and inventories of core materials and fission products in the damaged reactor core and compared with expected materials behavior to define materials, particularly fission product, behavior that may impact source term issues. 22 refs., 1 fig., 6 tabs.

19580 (EGG-M–88439) **Timing of the Three Mile Island Unit 2 core degradation as determined by forensic engineering.** Henrie, J.O. (Hydrogen Control, Inc., Panguitch, UT (USA)). EG and G Idaho, Inc., Idaho Falls, ID (USA). [1988]. 8p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-881024–22: TMI-2 accident materials behavior, plant technology and recovery, Washington, DC (USA), 30 Oct - 4 nov 1988). Order Number DE90007045. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Unlike computer simulation of an event, forensic engineering is the evaluation of recorded data and damaged as well as surviving components after an event to determine progressive causes of the event. Such an evaluation of the 1979 Three Mile Island Unit 2 accident indicates that gas began accumulating in steam, generator A at 6:10, or 130 min into the accident and, therefore, fuel cladding ruptures and/or zirconium-water reactions began at that time. Zirconium oxidation/hydrogen generation rates were highest (~70 kg of hydrogen per minute) during the core quench and collapse at 175

min. By 180 min, over 85% of the hydrogen generated by the zirconium-water reaction had been produced, and ~400 kg of hydrogen had accumulated in the reactor coolant system. At that time, hydrogen concentrations at the steam/water interfaces in both steam generators approached 90%. By 203 min, the damaged reactor core had been reflooded and has not been uncovered since that time. Therefore, the core was completely under water at 225 min, when molten core material flowed into the lower head of the reactor vessel. 10 refs., 7 figs., 1 tab.

19581 (EGG-M–89018) **RELAP5 electronic newsletter service.** Martin, S.L. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 6p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC07-76ID01570. (CONF-890173–5: 1. international RELAP-5 users seminar, College Station, TX (USA), 31 Jan - 2 feb 1989). Order Number DE90006962. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The RELAP5* Electronic Newsletter Service is a subscriber-funded information service provided by EG&G Idaho, Inc., to authorized recipients of the RELAP5/MOD2 computer code. This computer-based, electronic Newsletter Service contains technical information regarding the development and application of the RELAP5 computer code. Through modem-to-modem access to a dedicated IBM Personal Computer (PC) located at the Idaho National Engineering Laboratory (INEL), users may scan the Newsletter on their own PC or terminal and may download the contents to a local file. This report identifies which companies may subscribe to the Newsletter Service, describes the current Newsletter contents and plans for future enhancements, and narrates the procedures to access the Newsletter system.

19582 (HW–23178-Del.) **The tritium content of reactor water.** Healy, J.W. Hanford Works, Richland, WA (USA). 17 Jul 1951. 9p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. Order Number DE90007029. Available from NTIS, PC A02/MF A01 - OSTI.

Declassified 3 Oct 1989.

The problem of tritium in water irradiated in a reactor was first recognized at Hanford during an experiment in which the water was continuously circulated through one tube in the unit. Samples indicated a much higher concentration of tritium than could be expected from the flux and the capture cross section of deuterium. Since this phenomenon had wide implications for future work, a detailed study of this material was made in an attempt to prove conclusively that the activity measured was tritium and not a contaminating gas or volatile material that would carry over in the analysis. Later samples of other sources of irradiated water were analyzed and all were found to contain tritium.

19583 (IPEN-PUB–278) **CINETHICA - Core accident analysis code.** Nakata, H. Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo, SP (Brazil). Oct 1989. 15p. (In Portuguese). Order Number DE90617844. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A computer program for nuclear accident analysis has been developed based on the point-kinetics approximation and one-dimensional heat transfer model for reactivity feedback calculation. Hansen's method/1/were used for the kinetics equation solution and explicit Euler method were adopted for the thermohydraulic equations. The results were favorably compared to those from the GAPOTKIN Code/2/. (author).

19584 (KFK–4658) **Evaluation of forced reflooding experiments using the FLUT-FDWR-MM (modified version of FLUT-FDWR with moving mesh in heat conductor model).** Mori, T.; Cigarini, M.; Dalle Donne, M. Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Projektgruppe LWR-Sicherheit (PRS). Nov 1989. 76p. Order Number DE90753600. Available from NTIS (US Sales Only), PC A05/MF A01.

A new version of the FLUT-FDWR code, named FLUT-FDWR-MM, has been developed in KfK in order to reduce an oscillation trend observed in the predictions by the original code. In the new version, a finer mesh moving with the quench-front propagation is introduced into the heat conductor model. This version has been tested by means of post-test calculations of various reflooding experiments in both PWR (FEBA/SEFLEX, NEPTUN I and II) and APWR (NEPTUN III) geometries. The parameters R_v and R_i of Oseen's relation for interfacial drag between liquid and vapour phases are reoptimised for the new version. (orig.).

19585 (LA–11728-C, pp. 143-145) **Confidence building in and through fission and fusion activities.** Toyojiro Fuketa (Japan Atomic Energy Research Institute, Tokyo (Japan)). Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

The peaceful uses of atomic energy are most suitable for achieving worldwide confidence building for the following reasons. (1) In spite of the need for peaceful uses of nuclear energy, the world is facing difficulties in the public perception and acceptance of nuclear works and facilities. (2) The above difficulties are due to many factors, such as the two sides of nuclear energy peaceful and military, the possibility of a large-scale reactor accident, the lack of understanding about radiation and radioactivity, and finally, emotion and egoism. Some of these factors are unique to nuclear-energy, but in other cases of public reactions, there are many facets similar to the above factors. (3) The public concern about safety is at its highest, broadest and severest point ever, coincident with the highest life expectancy in history. Over-precaution and over-protection about certain things may sometimes spoil one's health. Nuclear energy is most definitely suffering from such a trend. As a result, a severe nuclear accident in any country results in severe damage worldwide no manner in what form the real physical effects reach other countries. (4) The huge science and technology efforts required for fission and fusion activities cannot be fully achieved by one country. Explanations of some of the above factors are given. 2 refs.

19586 (MLM–3620) **Technology Update-89.** Fitzharris, P.A. (ed.). EG and G Mound Applied Technologies, Miamisburg, OH (USA). Dec 1989. 33p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-88DP43495. Order Number DE90005813. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This December 1989 issue of Technology update tells about EG&G's role in the Galileo mission to land on Jupiter. Also covered in separate articles is information on tritium imaging, safety analysis of shipping containers, detection of small traces of various elements, and measuring methods. 18 refs., 42 figs., 2 tabs. (FSD)

19587 (NUREG–0797-Suppl.22) **Safety Evaluation Report related to the operation of Comanche Peak Steam Electric Station, Units 1 and 2 (Docket Nos. 50-445 and 50-446).** Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Reactor Regulation. Jan 1990. 368p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A16/MF A01 - GPO; OSTI; INIS.

Supplement 22 to the Safety Evaluation Report related to the operation of the Comanche Peak Steam Electric Station, Units 1 and 2 (NUREG-0797), has been prepared by the Office of Nuclear Reactor Regulation of the US Nuclear Regulatory Commission. The facility is located in Somervell County, Texas, approximately 40 miles southwest of Fort Worth, Texas. This supplement reports the status of certain issues that had not been resolved at the time of publication of the Safety Evaluation Report and Supplements 1, 2, 3, 4, 6, 12, and 21 to that report. This supplement also includes the evaluations for licensing items resolved since Supplement 21 was issued. Supplement 5 has been cancelled. Supplements 7 through 11 were limited to the staff evaluation of allegations investigated by the NRC Technical Review Team. Supplement 13 presented the staff's evaluation of the Comanche Peak Response Team (CPRT) Program Plan, which was formulated by the applicant to resolve various construction and design issues raised by sources external to the applicant. Supplements 14 through 20 presented the staff's evaluation of the applicant's Corrective Action Program and CPRT activities. Items identified in Supplements 7, 8, 9, 10, 11, 13, 14, and 15 through 20 are not included in this supplement, except to the extent that they affect the applicant's Final Safety Analysis Report. 154 refs., 24 figs., 8 tabs.

19588 (NUREG–1232-Vol.4) **Safety evaluation report on Tennessee Valley Authority: Watts Bar Nuclear Performance Plan: Volume 4, Watts Bar Unit 1.** Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Reactor Regulation. Jan 1990. 82p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A05/MF A01 - GPO; OSTI; INIS.

This safety evaluation report on the information submitted by the Tennessee Valley Authority in its Nuclear Performance Plan for the Watts Bar Nuclear Plant and in supporting documents has been prepared by the US Nuclear Regulatory Commission staff. The plan addresses the plant-specific corrective actions as part of the recovery program for licensing of Unit 1. The staff will be monitoring and inspecting the implementation of the programs. The plan does not address all licensing matters that will be required for fuel load and operation of Unit 1. Those remaining licensing matters have been addressed in previous safety evaluations or will be addressed in accordance with routing NRC licensing practices. 97 refs.

19589 (NUREG/CP–0097-Vol.2, pp. 1-56) **Meeting evolving reactor safety requirements.** Rubio, A. (Electric Power Research Institute, Palo Alto, CA (USA)); Vogel, R.C. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.2: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 2, industry safety research; non-destructive evaluation; materials engineering, pressure vessel research, radiation effects, degraded piping.* Available from NTIS, PC A17/MF A01 - I.

This paper gives an overview of the work being conducted by the Electric Power Research Institute (EPRI) in the reactor safety field. Topics covered include nuclear seismic research, nuclear reload management, systems reliability analysis, severe accident management, safety margins and testing (i.e., water hammer), source term investigations and control and diagnostics. The general philosophy behind the work is to be of help to the utilities which support EPRI in such a way that safety is enhanced, firstly, in protecting the public and, secondly, in protecting the very large investment represented by a nuclear power plant.

19590 (NUREG/CP–0097-Vol.2, pp. 57-70) **Scrubbing of aerosols by water pools.** Merilo, M. (Electric Power Research Institute, Palo Alto, CA (USA)); Gieseke, J.A.; Wassel, A.T. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.2: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 2, industry safety research; non-destructive evaluation; materials engineering, pressure vessel research, radiation effects, degraded piping.* Available from NTIS, PC A17/MF A01 - I.

During a severe core damage accident, the BWR suppression pool provides an important barrier to the release of radioactive fission product aerosols. The experimental components of this program consisted of small, intermediate, and large scale tests which were performed at Battelle Columbus Laboratories under a variety of conditions representative of those expected to occur during severe accidents. The analysis work culminated in the development of the SUPRA (SUppression Pool Retention Analysis) Code. This code is based on an engineering approach in that, wherever possible, correlations were used to describe individual phenomena, rather than mathematical models based on first principles. The results of an extensive comparison effort between the calculated and the experimental results are described, as well as, indications of the implications of these results to severe accident analysis.

19591 (NUREG/CP–0097-Vol.2, pp. 71-94) **Validation of FREY for the safety analysis of LWR fuel using transient fuel rod experiments.** George, J.A. (Texas A and M Univ., College Station (USA)); Peddicord, K.L.; Lin, C.L.; Montgomery, R.O.; Rashid, Y.R. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.2: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 2, industry safety research; non-destructive evaluation; materials engineering, pressure vessel research, radiation effects, degraded piping.* Available from NTIS, PC A17/MF A01 - I.

The analysis and comparison of severe light water reactor transient experiments are presented from the FREY verification and validation effort. The methods used to model the fuel, cladding, and coolant geometry are discussed in addition to experimental data comparisons. The purpose of this study was to validate the predictive capabilities of the code for severe transient analysis. The FREY code has been developed, under the sponsorship of the Electric Power Research Institute, for the thermomechanical analysis of LWR fuel rods under steady state and transient conditions. A two-dimensional finite-element computational method is used to represent both symmetric (r-z) and plane (r-θ) fuel geometries. The code can be used for both licensing and best estimate analyses. A total of 10 test fuel rods from experimental programs conducted in both the Power Burst Facility (PBF) and the Transient Reactor Test facility (TREAT) have been used in this study. The fuel rods were selected from the following test programs: Power Cooling Mismatch Tests, PCM-2 and PCM-4: Reactivity Initiated Accident Test, RIA 1-2; Loss-of-Coolant Accident Test, LOC-3; First Fuel Rod Failure Test, FRF-1; and Irradiation Effects Test, IE-3. The test programs used in this study cover a large range of code applications for severe transient analysis. The results of the PCM-2, RIA 1-2, and FRF-1 analyses are presented to highlight the full two-dimensional modeling capabilities of FREY and to compare the thermal and mechanical measurements with FREY prediction. The comparisons show good general agreement, with a tendency for FREY to overpredict the peak cladding surface temperature for a few cases where strong three-dimensional effects have been identified.

19592 (NUREG/CP–0097-Vol.2, pp. 95-106) **EPRI (Electric Power Research Institute) operator reliability experiments program.** Joksimovich, V. (Accident Prevention Group, Inc., San Diego, CA (USA)); Spurgin, A.J.; Orvis, D.D.; Moieni, P.; Worledge, D.H. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.2: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 2, industry safety research; non-destructive evaluation; materials engineering, pressure vessel research, radiation effects, degraded piping.* Available from NTIS, PC A17/MF A01 - I.

The primary purpose of the EPRI Operator Reliability Experiments (ORE) Program is to collect data for use in reliability and safety studies of nuclear power plant operation to more realistically take credit for operator performance in preventing core damage. The two objectives for fulfilling this purpose are: (1) to obtain quantitative/qualitative performance data on operating crew responses in the control room for potential accident sequences by using plant simulators, and (2) to test the Human Cognitive Reliability (HCR) correlation. This paper briefly discusses the background to this program, data collection and analysis, the results and quantitative/qualitative insights stemming from phase one which might be of interest to simulator operators and trainers.

19593 (NUREG/CP–0097-Vol.2, pp. 107-124) **STARRS [Secondary-side Transport and Retention of Radioactive Species]: A methodology to evaluate consequences of steam generator tube ruptures.** Kalra, S.P. (Electric Power Research Institute, Palo Alto, CA (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.2: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 2, industry safety research; non-destructive evaluation; materials engineering, pressure vessel research, radiation effects, degraded piping.* Available from NTIS, PC A17/MF A01 - I.

Steam generator tube rupture (SGTR) events which may occur in pressurized water reactors can lead to the release of radioactive species, such as iodine, to the environment. A fraction of the primary-side coolant and radioactive species which flow into the secondary-side through the ruptured tubes, will be retained in the

secondary-side and the rest will be released in the form of vapor and entrained aerosols. A mechanistic approach was used to develop the Secondary-side Transport and Retention of Radioactive Species (STARRS) computer code to quantify the amount, and composition of radioactive species released during an SGTR event. The STARRS code which simulates a U-tube steam generator contains a reactivity transport/retention module and thermal-hydraulic modules (which utilize the modular modeling system (MMS) routines). A version of the code called STARRS-TR was also developed which contains only the transport/retention module and which accepts the transient thermal-hydraulic parameters from general-purpose thermal-hydraulic system codes, such as RETRAN and TRAC. STARRS-TR calculates the radionuclide transport and deposition phenomena on the secondary-side of a U-tube steam generator, provided that boundary conditions such as the break flow and its thermodynamic conditions, system pressure, swell level height in the secondary side, etc., are known. In addition the STARRS code has been evaluated when coupled with a thermal-hydraulic MMS code, which provides required transient T/H conditions. Under this format, no separate thermal-hydraulic boundary conditions are needed as input.

19594 (NUREG/CP–0097-Vol.2, pp. 145-169) **Evaluation and improvement in nondestructive examination (NDE) reliability for inservice inspection of light water reactors.** Doctor, S.R. (Pacific Northwest Lab., Richland, WA (USA)); Deffenbaugh, J.D.; Good, M.S.; Green, E.R.; Heasler, P.G.; Simonen, F.A.; Spanner, J.C.; Taylor, T.T.; Vo, T. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.2: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 2, industry safety research; non-destructive evaluation; materials engineering, pressure vessel research, radiation effects, degraded piping.* Available from NTIS, PC A17/MF A01 - I.

The Evaluation and Improvement of NDE Reliability for Inservice Inspection of Light Water Reactors (NDE Reliability) program at the Pacific Northwest Laboratory was established by the NRC to determine the reliability of current inservice inspection (ISI) techniques and to develop recommendations that will ensure a suitably high inspection reliability. The objectives of this program include determining the reliability of ISI performed on the primary systems of commercial light-water reactors; using probabilistic fracture mechanics analysis to determine the impact of NDE unreliability on system safety; and evaluating reliability improvements that can be achieved with improved and advanced technology. A final objective is to formulate recommended revisions to ASME Code and Regulatory requirements, based on material properties, service conditions, and NDE uncertainties. The program scope is limited to ISI of the primary systems including the piping, vessel, and other inspected components. This is a progress report covering the programmatic work from October 1987 through September 1988.

19595 (NUREG/CP–0097-Vol.2, pp. 171-180) **Final developments, validation and technology transfer for AE (acoustic emission) and SAFT-UT (Synthetic Aperture Focusing of Ultrasonic Testing).** Doctor, S.R. (Pacific Northwest Lab., Richland, WA (USA)); Hutton, P.H.; Spanner, J.C.; Reid, L.D. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.2: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 2, industry safety research; non-destructive evaluation; materials engineering, pressure vessel research, radiation effects, degraded piping.* Available from NTIS, PC A17/MF A01 - I.

The program for validation and technology transfer for acoustic emission (AE) and Synthetic Aperture Focusing of Ultrasonic Testing (SAFT-UT) is designed to accomplish the final step of moving research results into beneficial application. Accomplishments for FY88 in the areas of AE and SAFT-UT data under this program are discussed in this paper. the information is treated under the topics of code activities, field validation, and seminars. Projected FY89 activities will continue to focus on these three areas.

19596 (NUREG/CP–0097-Vol.2, pp. 181-192) **Final evaluation of advanced and current leak detection systems.** Kupperman, D. (Argonne National Lab., IL (USA)); Carlson, R.; Lanham, R.; Brewer, W. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. DOE Contract W-31-109-ENG-38. (CONF-8810155–Vol.2: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 2, industry safety research; non-destructive evaluation; materials engineering, pressure vessel research, radiation effects, degraded piping.* Available from NTIS, PC A17/MF A01 - I.

This report presents the results of a study to evaluate the adequacy of leak detection systems in light water reactors. The sources of numerous reported leaks and methods of detection have been documented. Research to advance the state of the art of acoustic leak detection is presented, and procedures for implementation are discussed.

19597 (NUREG/CP–0097-Vol.2, pp. 193-199) **Eddy-current inspection for steam generator tubing program annual progress report for period ending December 31, 1988.** Dodd, C.V. (Oak Ridge National Lab., TN (USA)); Deeds, W.E.; Pate, J.R. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.2: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 2, industry safety research; non-destructive evaluation; materials engineering, pressure vessel research, radiation effects, degraded piping.* Available from NTIS, PC A17/MF A01 - I.

Reflection probes have demonstrated an improved capability to detect and size defects in degraded steam generators. The authors have been optimizing the reflection probes and the instrument operating parameters for steam generator inspections. Programs have been developed that accurately calculate the changes in the eddy-current signals produced by the many possible property variations such as tube sheets, tube supports, copper deposits, magnetite deposits, denting, and defects. Other programs compute the accuracy and sensitivity of eddy-current measurements of defects in the presence of these property variations. These programs have been run to optimize reflection, pancake and circumferential coils. A comparison between the optimum of each type showed that the reflection coils are best, the pancake coils next and the circumferential coils are worst. Both single reflection coil probes and an array of 16 reflection coils have been designed. The accuracy of the defect theory for reflection, pancake and circumferential coils and experimentally verified the theory have been studied. The newest inversion technique shows good potential for a direct and accurate determination of defect size and depth.

19598 (NUREG/CP–0097-Vol.2, pp. 125-144) **Risk management for the BWR plant.** Cushman, R.A. (Electric Power Research Institute, Palo Alto, CA (USA)); Hill, P.R.; Specter, H.; Wall, I.B. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.2: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 2, industry safety research; non-destructive evaluation; materials engineering, pressure vessel research, radiation effects, degraded piping.* Available from NTIS, PC A17/MF A01 - I.

The operational risk from a BWR plant can be significantly reduced by implementing a program which incorporates the elements of: (1) emergency operating procedures (i.e., accident management); (2) operator training; (3) transient analysis; (4) risk analysis; and (5) plant and operator performance monitoring. Large reductions in the calculated core melt and containment failure frequencies, relative to more standard PRA numbers, appear to be justified by the methodology presented herein. The methodology is based on employing realistic, rather than conservative assumptions in analysis; maximizing the use of available plant equipment (safety and non-safety related); taking full credit for operator

actions in carrying out well developed emergency operating procedures as a consequence of simulator training; and utilizing improved analytical techniques which more adequately describe core melt progression thus helping to identify success paths and develop emergency operating procedures.

19599 (NUREG/CP–0097-Vol.2, pp. 201-205) **Review of the status of nondestructive measurement techniques to quantify material property degradation due to aging and planning for further evaluation.** Doctor, S.R. (Pacific Northwest Lab., Richland, WA (USA)); Boyd, D.M.; Bruemmer, S.M.; Green, E.R.; Schuster, G.J.; Simonen, E.P. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. DOE Contract AC06-76RL01830. (CONF-8810155–Vol.2: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 2, industry safety research; non-destructive evaluation; materials engineering, pressure vessel research, radiation effects, degraded piping.* Available from NTIS, PC A17/MF A01 - I.

The materials used in nuclear reactors are inspected periodically during the service life of the power plant to detect degradation that might occur. These inspections follow the rules specified in Section XI of the ASME Boiler and Pressure Vessel Code. These inspections are designed to detect service-induced failure mechanisms. This program is designed not to look at the detection of defects but the making of nondestructive measurements to quantify the material properties that a defect may reside in or the incipient condition(s) that may initiate a defect. This program is intended to provide an assessment of the technologies that are available to quantify with nondestructive measurements material properties or material property changes related to degradation due to aging of structural components in light water reactors. In addition, a program plan will be developed that describes the work necessary to create adequate engineering data bases for demonstrating and validating prototypic systems for making these measurements. The main thrust this year has been an extensive review of literature and an assessment of the technology. The second major activity was the planning of a workshop to bring together 30 leading experts in materials and nondestructive evaluation to discuss the state-of-the-art and to address where future work should go.

19600 (NUREG/CP–0097-Vol.2, pp. 207-210) **Progress in research and standards activities in the materials engineering branch for 1988.** Serpan, C.Z. Jr. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.2: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 2, industry safety research; non-destructive evaluation; materials engineering, pressure vessel research, radiation effects, degraded piping.* Available from NTIS, PC A17/MF A01 - I.

The paper is divided into two sections: (1) Rules, guides, and Codes in which the achievements this year in the publication of rules, guides, and code documents are noted; and (2) Research and application in which the results and status of the Heavy Section Steel Technology program, piping research, water chemistry research for boiling water and pressurized water reactors, steam generator tube integrity research, and ultrasonic testing research are presented.

19601 (NUREG/CP–0097-Vol.2, pp. 211-235) **Impact of radiation embrittlement on integrity of pressure vessel supports for two PWR (pressurized water reactor) plants.** Cheverton, R.D. (Oak Ridge National Lab., TN (USA)); Pennell, W.E.; Robinson, G.C.; Nanstad, R.K. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. DOE Contract AC05-84OR21400. (CONF-8810155–Vol.2: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 2, industry safety research; non-destructive evaluation; materials engineering, pressure vessel research, radiation effects, degraded piping.* Available from NTIS, PC A17/MF A01 - I.

Recent pressure-vessel surveillance data from the High Flux Isotope Reactor (HFIR) indicate an embrittlement fluence-rate effect that is applicable to the evaluation of the integrity of light-water reactor (LWR) pressure vessel supports. A preliminary evaluation using the HFIR data indicated increases in the nil ductility transition temperature at 32 effective full-power years (EFPY) of 100 to 130°C for pressurized water reactor (PWR) vessel supports located in the cavity at midheight of the core. This result indicated a potential problem with regard to life expectancy. However, an accurate assessment required a detailed, specific-plant, fracture-mechanics analysis. After a survey and cursory evaluation of all LWR plants, two PWR plants that appeared to have a potential problem were selected. Results of the analyses indicate minimum critical flaw sizes small enough to be of concern before 32 EFPY.

19602 (NUREG/CP–0097-Vol.2, pp. 237-262) **Fracture resistance characterization for LWR (light water reactor) materials.** Hackett, E.M. (David Taylor Research Center, Annapolis, MD (USA)); Joyce, J.A. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.2: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 2, industry safety research; non-destructive evaluation; materials engineering, pressure vessel research, radiation effects, degraded piping.* Available from NTIS, PC A17/MF A01 - I.

The objectives of this investigation were to; (1) present experimental results and development of an experimental analysis which attempt to define the limits of the J singularity controlled region of crack extension in bend type laboratory fracture mechanics specimens; and (2) develop and examine a J-R curve extrapolation technique. Current limitations on J-controlled crack growth as described in ASTM E1152-87 are highly restrictive. This is particularly limiting in fracture analyses of nuclear plant structures which require development of J-R curves with large amounts of crack extension for use in instability analyses. Moreover, the E1152 limitations have not corresponded to observed experimental phenomena that could be taken to identify the loss of the singularity in a bend type fracture mechanics specimen. Additionally, an extension of the valid region of crack extension for a J-R curve from a laboratory specimen, does not often provide crack growth resistance information at large amounts of crack growth. In such cases, extrapolations may be required. There are, at present, no standardized approaches for extrapolating J-R curves obtained from small specimens to predict the crack growth resistance of larger specimens or structures. Results of the J-R curve and blunt-notched specimen tests indicate experimental support for extension of the E1152 crack growth validity limits to approximately 30% of the initial remaining ligament. A J-R curve extrapolation technique is described which is based on a simple power law fit to J-R curve data in the above-defined singularity region. While this approach is not verified in a general sense, it does correspond to measured data in most cases for which data is presently available.

19603 (NUREG/CP–0097-Vol.2, pp. 263-290) **Advances in crack-arrest technology for reactor pressure vessels.** Bass, B.R. (Oak Ridge National Lab., TN (USA)); Pugh, C.E. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. DOE Contract AC05-84OR21400. (CONF-8810155–Vol.2: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 2, industry safety research; non-destructive evaluation; materials engineering, pressure vessel research, radiation effects, degraded piping.* Available from NTIS, PC A17/MF A01 - I.

The Heavy-Section Steel Technology (HSST) Program at the Oak Ridge National Laboratory (ORNL) under the sponsorship of the US Nuclear Regulatory Commission is continuing to improve the understanding of conditions that govern the initiation, rapid propagation, arrest, and ductile tearing of cracks in reactor pressure vessel (RPV) steels. This paper describes recent advances in a coordinated effort being conducted under the HSST Program by

ORNL and several subcontracting groups to develop the crack-arrest data base and the analytical tools required to construct inelastic dynamic fracture models for RPV steels. Large-scale tests are being carried out to generate crack-arrest toughness data at temperatures approaching and above the onset of Charpy upper-shelf behavior. Small- and intermediate-size specimens subjected to static and dynamic loading are being developed and tested to provide additional fracture data for RPV steels. Viscoplastic effects are being included in dynamic fracture models and computer programs and their utility validated through analyses of data from carefully controlled experiments. Recent studies are described that examine convergence problems associated with energy-based fracture parameters in viscoplastic-dynamic fracture applications. Alternative techniques that have potential for achieving convergent solutions for fracture parameters in the context of viscoplastic-dynamic models are discussed.

19604 (NUREG/CP–0097-Vol.2, pp. 291-317) **HSST wide-plate test results and analysis.** Naus, D.J. (Oak Ridge National Lab., TN (USA)); Bass, B.R.; Keeney-Walker, J.; Fields, R.J.; deWit, R.; Low, S.R. III. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. DOE Contract AC05-84OR21400. (CONF-8810155–Vol.2: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 2, industry safety research; non-destructive evaluation; materials engineering, pressure vessel research, radiation effects, degraded piping.* Available from NTIS, PC A17/MF A01 - I.

Fifteen wide-plate crack-arrest tests have been completed to date, ten utilizing specimens fabricated from A533B class 1 material (WP-1 and WP-CE series), and five fabricated from a low upper-shelf base material (WP-2 series). Each test utilized a single-edge notched specimen that was subjected to a linear thermal gradient along the plane of crack propagation. Test results exhibit an increase in crack-arrest toughness with temperature, with the rate of increase becoming greater as the temperature increases. When the wide-plate test results are combined with other large-specimen results the data show a consistent trend in which the K_{Ia} data extends above the limit provided in ASME Section XI.

19605 (NUREG/CP–0097-Vol.2, pp. 319-354) **Summary of the heavy-section steel technology program irradiation series.** Nanstad, R.K. (Oak Ridge National Lab., TN (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.2: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 2, industry safety research; non-destructive evaluation; materials engineering, pressure vessel research, radiation effects, degraded piping.* Available from NTIS, PC A17/MF A01 - I.

The Heavy-Section Steel Technology (HSST) Program has considered the effects of radiation on pressure vessel steels since its inception in 1967. Research has focused on the conduct of experiments in test reactors to investigate the fracture toughness of both base metals and welds as a consequence of neutron irradiation under conditions similar (with the exception of irradiation rate) to those experienced by commercial power reactor vessels. The materials used for all the studies have been prototypic of commercial practice. The welds and plates are procured from commercial nuclear fabricators and fabricated using the same procedures used for reactor vessels. The HSST irradiation task currently includes ten separate series; four have been completed, three are active, and three are under planning. This paper briefly summarizes the results from the completed series, discusses the results from Series 5 on the K_{Ic} curve shift and shape in some detail, and briefly summarizes the remaining series.

19606 (NUREG/CP–0097-Vol.2, pp. 355-370) **Results of irradiated cladding tests and clad plate experiments.** Haggag, F.M. (Oak Ridge National Lab., TN (USA)); Iskander, S.K. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. DOE Contract AC05-84OR21400. (CONF-8810155–Vol.2: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 2, industry safety research; non-destructive evaluation; materials engineering, pressure vessel research, radiation effects, degraded piping.* Available from NTIS, PC A17/MF A01 - I.

Two aspects critical to the fracture behavior of three-wire stainless steel cladding were investigated by the Heavy-Section Steel Technology (HSST) Program: (1) radiation effects on cladding strength and toughness, and (2) the response of mechanically loaded flawed structures in the presence of cladding (clad plate experiments). Postirradiation testing results show that, in the test temperature range from −125 to 288°C, the yield strength increased, and ductility insignificantly increased, while there was almost no change in ultimate tensile strength. All cladding exhibited ductile-to-brittle transition behavior during Charpy impact testing. Radiation damage decreased the Charpy upper-shelf energy by 15 to 20% and resulted in up to 28°C shifts of the Charpy impact transition temperature. Results of irradiated 12.5-mm-thick compact specimens (0.5TCS) show consistent decreases in the ductile fracture toughness, J_{Ic}, and the tearing modulus. Results from clad plate tests have shown that (1) a tough surface layer composed of cladding and/or heat-affected zone has arrested running flaws under conditions where unclad plates have ruptured, and (2) the residual load-bearing capacity of clad plates with large subclad flaws significanctly exceeded that of an unclad plate.

19607 (NUREG/CP–0097-Vol.2, pp. 371-392) **General developments from NRCs Degraded Piping Program.** Wilkowski, G.M.; Ahmad, J.; Barnes, R.; Brust, F.; Ghadiali, N.; Guerrieri, D.; Kramer, G.; Landow, M.; Marschall, C.; Olson, R. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (USA). Mar 1989. (CONF-8810155–Vol.2: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). In *Sixteenth water reactor safety information meeting. Proceedings: Volume 2, industry safety research; non-destructive evaluation; materials engineering, pressure vessel research, radiation effects, degraded piping.* Available from NTIS, PC A17/MF A01 - I.

The NRCs Degraded Piping Program - Phase II started in April of 1984. Its main objective was to validate the fracture behavior of circumferentially cracked nuclear piping at quasi-static loading rates. The validation involved conducting pipe fracture experiments at LWR conditions which were used to assess various fracture analyses. These data were then used to validate and development analysis procedures for leak-before-break or inservice flaw inspection criteria such as ASME Section XI IWB-3640 and 3650. The full-scale experimental efforts involved conducting pipe fracture experiments on various nuclear grade pipes at LWR temperatures. The material characterization efforts involves two aspects. The first aspect to evaluate the material properties of each pipe necessary for flaw evaluation analyses. The second aspect of the material characterization effort involved specific investigations described in the paper. The material characterization, pipe experiment, and analytical efforts from the program are summarized in the sections. Afterwards, the significance of some of these results and future needs are discussed.

19608 (NUREG/CR–3145-Vol.8) **Geophysical investigations of the western Ohio-Indiana region: Annual report, October 1988–September 1989: Volume 8.** Young, C.J. (Michigan Univ., Ann Arbor, MI (USA). Dept. of Geological Sciences); Lay, T.; Jacobson, J. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; Michigan Univ., Ann Arbor, MI (USA). Dept. of Geological Sciences. Feb 1990. 20p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC E04/MF E01 - GPO - OSTI.

This report contains 1 microfiche supplement.

Earthquake activity in the Western Ohio-Indiana region has been monitored with a precision seismograph network consisting of nine stations located in west-central Ohio and four stations located in Indiana. Three local earthquakes have been recorded during this report period, with magnitudes ranging from 0.7 to 2.2. This may represent a return to a more normal local level of seismicity after an anomalously low level in the two years following the occurrence of the $m_b = 4.5$ earthquake, in St. Marys, Ohio on July 12, 1986. If

the quiescent period reflected a release of most of the accumulated crustal strain by the St. Marys event, then the increased level of seismicity may mark the beginning of a new phase of strain accumulation. Four regional events were also well recorded by the array stations during this year. All of these events occurred in regions with well established histories of seismicity. Their magnitudes range from 3.1 to 4.4. 7 refs., 11 figs., 3 tabs.

19609 (NUREG/CR–4674-Vol.9) **Precursors to potential severe core damage accidents, 1988: A status report: Main report and Appendix A.** Minarick, J.W. (Science Applications International Corp., Oak Ridge, TN (USA)); Blake, A.A.; Cletcher, J.W. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Safety Programs; Oak Ridge National Lab., TN (USA). Feb 1990. 164p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC05-84OR21400. (ORNL/NOAC–232-Vol.9). Available from NTIS, PC A08/MF A01 - GPO; OSTI; INIS.

Thirty-two operational events with conditional probabilities of core damage of 1.0×10^{-6} or higher occurring at commercial light-water reactors during 1988 are considered to be precursors to potential severe core damage. These are described along with associated significance estimates, categorization, and subsequent analyses. This study is a continuation of earlier work, which evaluated the 1969–1981 and 1984–1987 events. The report discusses (1) the general rationale for this study, (2) the selection and documentation of events as precursors, (3) the estimation and use of conditional probabilities of subsequent severe core damage to rank precursor events, and (4) the plant models used in the evaluation process. 9 refs., 25 figs., 34 tabs.

19610 (NUREG/CR–5395-Vol.2) **Multiloop Integral System Test (MIST): Final report: Test group 30, mapping tests: Volume 2.** Geissler, G.O. (Babcock and Wilcox Co., Lynchburg, VA (USA). Nuclear Power Div.). Nuclear Regulatory Commission, Washington, DC (USA). Div. of Systems Research; Electric Power Research Inst., Palo Alto, CA (USA); Babcock and Wilcox Owners Group, Lynchburg, VA (USA); Babcock and Wilcox Co., Lynchburg, VA (USA). Nuclear Power Div.; Babcock and Wilcox Co., Alliance, OH (USA). Research and Development Div. Dec 1989. 554p. Sponsored by Nuclear Regulatory Commission. (EPRI-NP–6480-Vol.2;BAW–2080-Vol.2). Available from NTIS, PC E20/MF E09 - GPO; OSTI; INIS.

This report contains 35 microfiche supplements.

The Multiloop Integral System Test (MIST) is part of a multiphase program started in 1983 to address small-break loss-of-coolant accidents (SBLOCAs) specific to Babcock and Wilcox designed plants. MIST is sponsored by the US Nuclear Regulatory Commission, the Babcock & Wilcox Owners Group, the Electric Power Research Institute, and Babcock and Wilcox. The unique features of the Babcock and Wilcox design, specifically the hot leg U-bends and steam generators, prevented the use of existing integral system data or existing integral facilities to address the thermal-hydraulic SBLOCA questions. MIST and two other supporting facilities were specifically designed and constructed for this program, and an existing facility – the Once Through Integral System (OTIS) – was also used. Data from MIST and the other facilities will be used to benchmark the adequacy of system codes, such as RELAP5 and TRAC, for predicting abnormal plant transients. The MIST program is reported in 11 volumes. The program is summarized in Volume 1; Volumes 2 through 8 describe groups of tests by test type; Volume 9 presents inter-group comparisons; Volume 10 provides comparisons between the calculations of RELAP5/MOD2 and MIST observations, and Volume 11 presents the later Phase 4 tests. This Volume 2 pertains to MIST mapping tests performed to traverse the early post-SBLOCA events slowly. The tests investigated the effect of test-to-test variations in boundary system controls, and only the primary fluid mass varied during a specific test in this test group. 5 refs., 415 figs., 12 tabs.

19611 (NUREG/CR–5419) **Aging assessment of instrument air systems in nuclear power plants.** Villaran, M. (Brookhaven National Lab., Upton, NY (USA)); Fullwood, R.; Subudhi, M. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; Brookhaven National Lab., Upton, NY (USA). Jan 1990. 137p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC02-76CH00016. (BNL-NUREG–52212). Available from NTIS, PC A07/MF A01 - GPO; OSTI; INIS.

NRC Generic Issue 43, "Contamination of Instrument Air Lines", has been unresolved since 1980. The potential seriousness of this issue was reinforced in a 1987 study by the Office for Analysis and Evaluation of Operational Data. Aging of components within compressed air systems, leading to degraded function of the system, is the subject of this study. This work was performed under the auspices of the NRC's Office of Nuclear Regulatory Research as part of the Nuclear Plant Aging Research (NPAR) Program. The objective of this study was to identify all the aging modes and their causes, which should be mitigated to achieve a reliable operation of all safety-related air equipment. Also included is an interim review of typical maintenance activities for air systems in the nuclear power industry. The Phase 2 effort of this study will make recommendations for developing an effective maintenance program industry-wide to counter the effects of aging. The analysis of operating experience data revealed that aging degradation occurs in the compressed air system, and becomes a factor as the system ages. Normal wear of the system and contamination of the air dominate the problems of system failure. Existing maintenance programs within the industry lack uniformity, and quality assurance is not rigorous because the system is classified as non-safety. 16 refs., 33 figs., 11 tabs.

19612 (NUREG/CR–5472) **A risk-based review of instrument Air systems at nuclear power plants.** DeMoss, G. (Science Applications International Corp., McLean, VA (USA)); Lofgren, E.; Rothleder, B.; Villeran, M.; Ruger, C. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Systems Research; Brookhaven National Lab., Upton, NY (USA); Science Applications International Corp., McLean, VA (USA). Jan 1990. 160p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC02-76CH00016. (BNL-NUREG–52220). Available from NTIS, PC A08/MF A01 - GPO; OSTI; INIS.

The broad objective of this analysis was to provide risk-based information to help focus regulatory actions related to Instrument Air (IA) systems at operating nuclear power plants. We first created an extensive data base of summarized and characterized IA-related events that gave a qualitative indication of the nature and severity of these events. Additionally, this data base was used to calculate the frequencies of certain events, which were used in the risk analysis. The risk analysis consisted of reviewing published PRAs and NRC Accident Sequence Precursor reports for IA-initiated accident sequences, IA interactions with frontline systems, and IA-related risk significant events. Sensitivity calculations were performed when possible. Generically, IA was found to contribute less to total risk than many safety systems; however, specific design weaknesses in safety systems, non-safety systems, and the IA system were found to be significant in risk. 22 refs., 13 figs., 24 tabs.

19613 (ORNL–6554) **Proposed and existing passive and inherent safety-related structures, systems, and components (building blocks) for advanced light-water reactors.** Forsberg, C.W.; Moses, D.L.; Lewis, E.B.; Gibson, R.; Pearson, R.; Reich, W.J.; Murphy, G.A.; Staunton, R.H.; Kohn, W.E. Oak Ridge National Lab., TN (USA). Oct 1989. 331p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE90006441. Available from NTIS, PC A15/MF A01; OSTI; INIS; GPO Dep.

A nuclear power plant is composed of many structures, systems, and components (SSCs). Examples include emergency core cooling systems, feedwater systems, and electrical systems. The design of a reactor consists of combining various SSCs (building blocks) into an integrated plant design. A new reactor design is the result of combining old SSCs in new ways or use of new SSCs. This report identifies, describes, and characterizes SSCs with passive and inherent features that can be used to assure safety in light-water reactors. Existing, proposed, and speculative technologies are described. The following approaches were used to identify the technologies: world technical literature searches, world patent searches, and discussions with universities, national laboratories and industrial vendors. 214 refs., 105 figs., 26 tabs.

19614 (UCID–21829) **Princeton Plasma Physics Laboratory (PPPL) seismic hazard analysis.** Savy, J. Lawrence Livermore

National Lab., CA (USA). 1 Oct 1989. 143p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract W-7405-ENG-48. Order Number DE90006356. Available from NTIS, PC A07/MF A01; OSTI; INIS.

New design and evaluation guidelines for department of energy facilities subjected to natural phenomena hazard, are being finalized. Although still in draft form at this time, the document describing those guidelines should be considered to be an update of previously available guidelines. The recommendations in the guidelines document mentioned above, and simply referred to as the "guidelines" thereafter, are based on the best information at the time of its development. In particular, the seismic hazard model for the Princeton site was based on a study performed in 1981 for Lawrence Livermore National Laboratory (LLNL), which relied heavily on the results of the NRC's Systematic Evaluation Program and was based on a methodology and data sets developed in 1977 and 1978. Considerable advances have been made in the last ten years in the domain of seismic hazard modeling. Thus, it is recommended to update the estimate of the seismic hazard at the DOE sites whenever possible. The major differences between previous estimates and the ones proposed in this study for the PPPL are in the modeling of the strong ground motion at the site, and the treatment of the total uncertainty in the estimates to include knowledge uncertainty, random uncertainty, and expert opinion diversity as well. 28 refs.

19615 (WSRC-RP–89-1241) **Trip report: European Communities 1989 International Conference on Decommissioning of Nuclear Installations, Brussels, Belgium, October 24-27, 1989.** Rankin, W.N. Westinghouse Savannah River Co., Aiken, SC (USA). 1989. 16p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90007117. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The European community is conducting research on the decommissioning of nuclear installations. The prime objective is to develop effective techniques to ensure the protection of man and his environment against the potential hazards of nuclear installations that have been shut down. The results of the 1979–1983 research program were presented in a conference held in Luxembourg. This program was primarily concerned with decommissioning nuclear power plants. The 1984–1988 program was extended to all types of nuclear installations. Fuel fabrication, enrichment and reprocessing plants, and research and development facilities having fulfilled their useful purposes are also awaiting decommissioning. This Program has produced numerous scientific and technical achievements. Great progress has in particular been achieved in the reduction of metal waste arising from decommissioning, due to advances in areas such as the development of aggressive decontamination procedures and of techniques for melting and recycling low-level radioactive waste metal.

24 POWER TRANSMISSION AND DISTRIBUTION

19616 (CRIE-W–88017) **Long-term performances of wound core type amorphous metal transformers.** Kato, Masao; Sato, Masahiko; Fukagawa, Hirotada. Central Research Inst. of Electric Power Industry, Tokyo (Japan). Jan 1989. 35p. (In Japanese). Order Number DE90753093. Available from NTIS (US Sales Only), PC A03/MF A01.

In order to achieve a sharp reduction of the losses of distribution transformers, the magnetic stability of wound core type amorphous metal transformers has been studied. In the term of electrical tests over about two years, a short-circuit current with twenty times as large as a rated current was transmitted for two seconds every half year, and the mechanical stresses by electromagnetic interaction were applied to core and winding. Before and after those tests, the characteristics of transformers were measured. Furthermore, the effects of amorphous magnetic materials on the degradation of insulating oil were also examined through gas analyses in the oil. The core losses showed no significant changes after subjected to the thermal stresses equivalent to more than twenty years operation at 60^0C. There were no changes of transformers performances due to the mechanical stresses by the short-circuit test. The exciting currents of some transformers were found to be largely influenced by core temperature due to the designs. No abnormalities are found in the results of gas analyses in the oil and breakdown voltage tests, differences between conventional silicon steel and the amorphous magnetic metal are not shown. 6 refs., 16 figs., 9 tabs.

19617 (CRIE-W–88020) **Development of Visual designed pole-mounted underground power distribution equipments.** Sawabe, Kimihide; Ito, Tetsuo; Sato, Masahiko; Iwadate, Takahiro; Imajo, Tadahisa; Kamikawa, Kazuo. Central Research Inst. of Electric Power Industry, Tokyo (Japan). Feb 1989. 44p. (In Japanese). Order Number DE90753092. Available from NTIS (US Sales Only), PC A03/MF A01.

In order to reduce the construction cost, the pole-mounted underground power distribution systems, which are able to set the equipments in narrow space where is impossible to place by pad-mounted method, were designed. This report describes experimental and theoretical considerations on the feasibility study of the pole-mounted transformers for the realization of the systems. The transformer is set in the visual designed housing and mounted on the pole. High-tension and low-tension cables are introduced separately into the pole through reinforced flexible tubes. It was found that the opening rates of housing which release heat effectively from the transformer need only a few per-cent in utility. To resist the wind pressure and the earthquake load, the pole strength and the setting depth were designed. The pole-mounted transformers were installed through the system design, and the possibility of realizing transformer on working was verified. 7 refs., 18 figs., 10 tabs.

19618 (CRIE-W–88027) **Arc-guide performance of non symmetric type arc horns for 22kV long-rod insulators.** Chino, Takashi; Okazaki, Masayuki. Central Research Inst. of Electric Power Industry, Tokyo (Japan). Apr 1989. 30p. (In Japanese). Order Number DE90753097. Available from NTIS (US Sales Only), PC A03/MF A01.

For long-rod insulators used on 22kV overhead distribution lines, it is thought to apply arc horns to prevent breakage of insulator by the arc generated on the insulators but there are still some unclear points. This report studied the arc guide performance when a non-symmetric type arc horn is mounted on the 22kV long-rod insulator. In this experiment, arc was initiated on each circumferential point of voltage impressed side and basic metal of arm metal side to study the arc guide transferring time to the horn. When the voltage impressed side was not covered by the insulating cover, arcs generated on the insulator surface by flashover were guided to the arc horn. When the voltage impressed side was covered by the insulatiing cover, the horn of voltage impressed side was difficult to guide arcs to the arc horn. But when the top of arm metal side horn was directed to the top of the voltage impressed side, the arc horn of voltage impressed side could guide arcs. This non-symmetric arc horns can protect the insulators since this has suffucient arc guide performance. 4 refs., 16 figs.

2401 Power Systems

19619 (EPRI-GS–6687) **Potential economic benefits of battery storage to electrical transmission and distribution systems: Final report.** Zaininger, H.W. (Power Technologies, Inc., Roseville, CA (USA)); Clark, H.K.; Brownell, G.C. Electric Power Research Inst., Palo Alto, CA (USA); Power Technologies, Inc., Roseville, CA (USA). c Jan 1990. 135p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Presently, most of the Electric Power Research Institute work assessing battery storage impacts on electric utility systems has been performed on a non-site specific basis, using generation planning and operational simulation methodology. This approach is very useful for first-cut long-term economic benefit assessments, but it neglects battery storage impacts on electrical transmission and distribution (T&D) systems. Battery storage installations have significant siting flexibility and dynamic operating capability compared to many other generation alternatives. Assessment of many associated potential battery storage benefits requires site-specific transmission and distribution system analysis. The purpose of this

project was to perform an initial example economic analysis of the potential impact battery storage on a partial list of transmission and distribution system costs. This initial example study addressed three of the most apparent potential transmission and distribution (T&D) system benefits associated with the installation of battery storage: T&D system reliability and deferral of new T&D facilities; relative T&D system electrical losses; and impacts on stability limited transmission system. This initial study indicates that installing batteries in the best locations may result in substantial T&D system benefits. 3 refs., 48 figs., 24 tabs.

2402 Power System Networks, Transmission and Distribution

19620 (CRIE-Y–89002) **Landscape assessment system of electric transmission and transformer facilities.** Wakatani, Yoshifumi; Yamamoto, Kimio. Central Research Inst. of Electric Power Industry, Tokyo (Japan). Jun 1989. 49p. (In Japanese). Order Number DE90753070. Available from NTIS (US Sales Only), PC A03/MF A01.

In construction of electric transmission and transformer facilities, it is important to conduct a landscape assessment and to investigate adequate countermeasures. In this study, it is aimed that the conventional landscape assessment system for construction of a thermal/atomic power plant is improved to apply to the electric transmission and transformer facilities. The results are summarized as follows. For the prediction system, sphere maps of landscape influence for the extraction of effective view points and programs for computer perspectives which is required in an accurate depiction of a montage picture of the subject, were developed. Due to marked differences between the thermal/atomic power plant and the electric transmission and transformer facilities in their configurations and the site conditions, individual evaluation methods were developed together with the establishment of new evalution items. Furthermore, the weights of evaluation items for synthetic evaluation values were established. As the results of case studies, it is revealed that the system is practical in application to the site. 30 figs., 13 tabs.

2403 Power Transmission Lines and Cables

Refer also to citation(s) 19945

19621 (EPRI-GS–6642) **Time-domain reflectometry for monitoring cable changes: Feasibility study: Final report.** Steiner, J.P. (Purdue Univ., Lafayette, IN (USA). School of Electrical Engineering); Weeks, W.L. Electric Power Research Inst., Palo Alto, CA (USA); Purdue Univ., Lafayette, IN (USA). School of Electrical Engineering. c Feb 1990. 59p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This report presents the results of a preliminary study of the potential of enhanced time domain reflectometry in the electrical monitoring of cable changes. It was demonstrated that on both shielded and non-shielded cables, very small stresses can be detected. The stresses included cable heating, cable compression and bending, and immersion in water. It was concluded that almost continuous monitoring would be required to identify these small indicators of cable stress and aging. 24 figs.

2405 Environmental Aspects

Refer also to citation(s) 19691

2407 Economic, Industrial, and Business Aspects

Refer also to citation(s) 19716

25 ENERGY STORAGE

2502 Compressed and Liquefied Gas

Refer also to citation(s) 20105

19622 (EPRI-GS–6671) **Compressed-air energy storage field test using the aquifer at Pittsfield, Illinois: Final report.** Istvan, J.A. (PB-KBB, Inc., Houston, TX (USA)); Pereira, J.C.; Roark, P.; Bakhtiari, H. Electric Power Research Inst., Palo Alto, CA (USA); PB-KBB, Inc., Houston, TX (USA). c Feb 1990. 395p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This report describes the design, construction, and operation of a field experiment to examine feasibility of full-scale compressed air energy storage (CAES) within aquifer reservoirs. A summary of data obtained and the conclusions from the field experiment are presented. Two injection/withdrawal wells, two instrument wells, and four logging/sampling wells were drilled and cored. Air was injected in the St. Peter Sandstone to create an air bubble which was cycled with ambient and elevated temperature air in the injection withdrawal pattern contemplated for CAES installations. At its peak content of 111.75×10^6 scf, the air bubble was 30 ft thick at the I/W well area and reached 18 ft in thickness at a distance of 686 ft from the I/W well. Three post-test core wells were drilled and cored. The caprock, reservoir, and formation water were sampled and analyzed prior to and after exposure to compressed air and associated water. Samples of stored air were collected and analyzed. Items of interest were degree of liquid entrance into flowing well, effects in aquifer of increased air temperature, and changes in oxygen content of air. Prior to plugging and abandoning the well field, an additional well was drilled and cored, outside the air bubble. This work is part of the continuing research by EPRI to investigate the geochemical oxidation process. Reservoir engineering and utilization of geologic media for storing air has many complexities, but it has useable experience from successful natural gas storage. The design, construction, and testing at Pittsfield demonstrates that orientation toward useage of an aquifer air storage facility can be performed successfully. The disappearance of oxygen needs attention for seasonal storage of air but should not dampen enthusiasm for weekly or daily storage cycles.

2506 Thermal

Refer also to citation(s) 19762, 19763

19623 Thermal energy storage for cooling of commercial buildings. Akbari, H. (Lawrence Berkeley Lab., CA (USA)); Mertol, A. pp. 756 of Energy storage systems. Kilkis, B.; Kakac, S. (eds.) Kluwer Academic Publishers, Dordrecht (Netherlands) (1989). DOE Contract AC03-76SF00098.

Systems with cold storage shift all or part of the electricity requirements from peak to off-peak hours and take advantage of reduced demand charges, off-peak rates and other financial incentives offered by the electric utilities which like to accelerate the penetration of this technology. Potential use of energy storage systems for cooling commercial buildings is investigated. In addition, a general overview of the technology is presented and the applicability and the cost-effectiveness of this technology for both developed and developing countries are discussed. An inventory of 269 buildings inside and 52 buildings outside the USA which have installed cold storage systems is given in appendix 2. 12 figs., 28 refs., 1 tab., 2 apps.

2509 Batteries

Refer also to citation(s) 19498, 19501, 19537, 19619, 19836, 19837, 20002, 20003, 20004, 20005, 20007, 20008, 20009, 20010, 20011

19624 (AD-A–214045/7/XAB) **Two-electron oxidation of cobalt phthalocyanines by thionyl chloride: Implications for lithium/thionyl chloride batteries. Technical report.** Bernstein, P.A.; Lever, A.B. York Univ., Downsview, ON (Canada). Dept. of

Chemistry. 20 Oct 1989. 41p. (TR–29). Available from NTIS, PC A03/MF A01.

Cyclic voltammetry, DPV and electronic spectroscopy are used to study the reaction between thionyl chloride and cobalt phthalocyanine. SOCl2 reacts with (Co(I)Tn Pc(2-)) and Co(II)Tn Pc(2-) to give two-electron oxidized species. Implications for Li/SOCl2 batteries are discussed. Thionyl chloride also forms a mono SOCl2 adduct with Co(II)TnPc(2-). Driving forces (Delta E values) were calculated for CoTnPc comproportionation and CoTnPc + SOCl2 reactions. Rest potential measurements of a Li/SOCl2 cells show that addition of AlCl3 stabilizes the LiCl product as LiAlCl4. A catalytic two-electron mechanism is indicated for the reduction of thionyl chloride in a Li/SOCl2/(CoTnPc,C) battery.

19625 (EGG-M–89410) **A battery data base for electric vehicle applications.** Burke, A.F.; Hardin, J.E.; Kiser, D.M. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 7p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC07-76ID01570. (CONF-890160–2: 4. annual battery conference on applications and advances, Long Beach, CA (USA), 17-19 Jan 1989). Order Number DE90007085. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Work is progressing on the development of a battery data base for electric vehicle applications. This data base is intended to provide the electric vehicle community access to the large volume of battery data taken at the Idaho National Engineering Laboratory (INEL), Argonne National Laboratory, and Sandia National Laboratory on a desk-top PC. The initial version of the data base will be distributed on a single floppy disk. The data base will include the physical characteristics of the various batteries tested as well as summary tables showing the test results for each cycle of the battery test programs. Second-by-second data from constant power discharges, peak power tests, and variable power SFUDS cycle tests will also be included in the data base. The data base is being prepared using dBASE IV. The user selects the battery and data desired through a series of screen displayed menus. The design of the data base and menus are complete and INEL battery summary table and data files are being read into the data base. Nearly 100 MB of data have been prepared for eventual inclusion into the data base. 1 ref.

19626 (N–90-12696) **Characterization and cycle tests of lightweight nickel electrodes.** Britton, D.L. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. 1989. 13p. (NASA-TM–102399;E–5153;NAS–1.15:102399;CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989). Available from NTIS, PC A03/MF A01.

Development of a high specific energy nickel electrode is the main goal of the lightweight nickel electrode program at NASA Lewis Research Center. The approach was to improve the nickel electrode by continuing combined in-house and contract efforts to develop a more efficient and lighter weight electrode for the nickel-hydrogen battery. High energy nickel electrodes suffer from having shorter lives than state-of-the-art electrode. However, these lightweight electrodes appear to be favorable for missions requiring moderate cycle lives and depth-of-discharge.

19627 (PNL–7230) **Cost and energy consumption estimates for the aluminum-air battery anode fuel cycle.** Humphreys, K.K.; Brown, D.R. Pacific Northwest Lab., Richland, WA (USA). Jan 1990. 68p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC06-76RL01830. Order Number DE90005810. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

At the request of DOE's Office of Energy Storage and Distribution (OESD), Pacific Northwest Laboratory (PNL) conducted a study to generate estimates of the energy use and costs associated with the aluminum anode fuel cycle of the aluminum-air (Al-air) battery. The results of this analysis indicate that the cost and energy consumption characteristics of the mechanically rechargeable Al-air battery system are not as attractive as some other electrically rechargeable electric vehicle battery systems being developed by OESD. However, there are distinct advantages to mechanically rechargeable batteries, which may make the Al-air battery (or other mechanically rechargeable batteries) attractive for other uses, such as stand-alone applications. Fuel cells, such as the proton exchange membrane (PEM), and advanced secondary batteries may be better suited to electric vehicle applications. 26 refs., 3 figs., 25 tabs.

19628 Surface characterization of PbO_2 and bi-modified PbO_2 electrodes: implications for oxygen transfer reactions. . Nielsen, B.S. (Iowa State Univ. of Science and Technology, Ames, IA (USA). Dept. of Chemistry); Davis, J.L.; Thiel, P.A. pp. 935 of The Electrochemical Society Spring meeting (extended abstracts). The Electrochemical Society, Pennington, NJ (1989). (CONF-890518–: 175. meeting of the Electrochemical Society, Los Angeles, CA (USA), 7-12 May 1989).

The surfaces of PbO_2 and Bi-doped PbO_2 (Bi-PbO_2) are studies using Auger electron spectroscopy (AES) and high resolution electron energy loss spectroscopy (EELS). Changes in the surface composition and vibrational features of the PbO_2 electrode, resulting from the introduction of Bi into the lattice, illuminate factors influencing the rate of anodic oxygen transfer reactions (OTRS).

19629 Studies of the kinetics of ion or electron transfer using an indirect laser-induced interfacial temperature-jump method. Geng, L. (Brookhaven National Lab., Upton, NY (USA). Applied Science Dept.); Smalley, J.F.; Feldberg, S.W. pp. 935 of The Electrochemical Society Spring meeting (extended abstracts). The Electrochemical Society, Pennington, NJ (1989). (CONF-890518–: 175. meeting of the Electrochemical Society, Los Angeles, CA (USA), 7-12 May 1989).

The indirect laser-induced interfacial temperature jump (ILIT) method has been elucidated in previous publications. Indirect heating distinguishes this approach from the direct (pulsed laser) heating, where the light impinges upon the electrode/electrolyte interface. The change in interfacial temperature (described by a virtually exact solution of the appropriate heat transport equations) is coupled to the various electrochemical phenomena that can effect a change in open-circuit potential. A master differential equation describes the open-circuit response for a variety of electron-transfer or ion des-ad kinetics. The effect of concomitant concentration polarization is included. The solution to the equation is obtained by standard Laplace transform techniques. At the present time the authors are able to obtain high quality data at times as short as 100 ns. Their analyses indicate that there are no apparent physical chemical impediments to the development of a sub-nanosecond capability. This paper describes the application of the ILIT method to the studies of the kinetics of ion transfer between the inner Helmholtz plane (IHP) and the outer Helmholtz plane (OHP) and to studies of electron transfer between a metal electrode and a variety of redox couples located at the IHP and/or OHP. Most of their experimental work thus far has utilized 12 μ thick poloycrystalline gold electrode foils. With a 10 ns Nd-YAG laser the effective rise-time (to 90%) of the interfacial temperature is –400 ns.

19630 Non-noble electrocatalysts. Sarangapani, S. (Giner, Inc., Waltham, MA (USA)); Lessner, P.; Manoukian, M.; Giner, J. pp. 935 of The Electrochemical Society Spring meeting (extended abstracts). The Electrochemical Society, Pennington, NJ (1989). (CONF-890518–: 175. meeting of the Electrochemical Society, Los Angeles, CA (USA), 7-12 May 1989).

Noble metals, when used as electrocatalysts for oxygen reduction in metal-air batteries and fuel cells, suffer from the disadvantages of high cost, susceptibility to poisoning and sintering. Carbons activated with macrocyclics have attracted increasing attention as alternative electrocatalysts for oxygen reduction. Initial activity of these catalysts is good, but performance declines rapidly. Pyrolyzing the macrocyclic on the carbon support leads to enhanced stability and the catalyst retains good activity. The exact nature of the catalytic sites after pyrolysis is still under investigation. Despite this promising method of treating macrocyclic activated carbon catalysts, the performance decay is still too large to be acceptable. Part of the stability problem occurs because the catalytic layer on the carbon surface is, at most, a few mono-layers thick. The approach described here is designed to develop bulk doped catalysts with similar structures to pyrolyzed macrocylic catalysts. The transition metal and coordinated ligands are dispersed throughout the bulk of the conductive carbon skeleton. Two

approaches to realizing this concept are being pursued, both involving the doping of carbon precursors.

2510 Economic, Industrial, and Business Aspects

Refer also to citation(s) 19627

29 ENERGY PLANNING AND POLICY

Refer also to citation(s) 19684, 19696, 19721, 19730

19631 (LA–11728-C, pp. 10-13) **Role of IAEA [International Atomic Energy Agency] safeguards in confidence building.** Augustson, R.H. Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

This paper examines some attributes of confidence building and connect them with how the International Atomic Energy Agency (IAEA) interacts with its member states in carrying out its safeguards function. These interactions and the structure set up to define them help maintain and strengthen confidence between the IAEA and the member states and among these states. The attributes of confidence building are presented and discussed. 3 refs.

19632 (LA–11728-C, pp. 14-19) **International collaboration on inherently safe nuclear reactors.** Barkenbus, J.N. (Univ. of Tennessee, Knoxville (USA)). Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

Science and technology transcend economic and political ideologies, providing a means of communications and approach common to both the United States and the Soviet Union. This paper suggests that the field of nuclear fission is a logical and productive area for superpower and broader collaboration, but that the kind of collaboration characteristic of past and present activity is less than it optimally could be. The case for cost sharing is compelling with budget constraints and mounting concerns over global warming. The case for collaboration is based on economic, psychological, and political grounds. A collaborative effort in nuclear fission is presented as a near term effort by building and testing of a prototype reactor in the 1990s.

19633 (LA–11728-C, pp. 20-28) **Geologic containment of radioactive waste.** Barr, D. Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

This paper presents the results of work and thoughts on resolving the uncertainties associated with the nature of the solubilities and speciation of actinides, the formation of radiocolloids, the sorption behavior of fission products and actinides, and the transport mechanisms of advection, diffusion, and dispersion for radionuclides under environmental conditions thought to exist at Yucca Mountain, Nevada. The research in process on chemical and physical processes important to conducting a performance assessment of this site is presented. 27 refs.

19634 (LA–11728-C, pp. 29-37) **Safety aspects of evolutionary and advanced reactors.** Beckjord, E.S. (Nuclear Regulatory Commission, Washington, DC (USA)). Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

Renewed interest in the use of nuclear power for the generation has come about not only from concerns about global warming, acid rain, and clean air, but also from advances in the reactor designs with the potential for enhanced safety of operations. The paper discusses the developments underway in industry, supported by the Department of Energy, and the safety evaluations being done by the Nuclear Regulatory Commission on the evolutionary and advanced reactor designs. 3 figs., 1 tab.

19635 (LA–11728-C, pp. 38-40) **International disaster relief: Obstacles to immediate response.** Bighinatti, E.V. Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

The paper provides a brief overview on how the International Red Cross was formulated and the system under which it conducts its global relief operations. Technology advances have greatly benefited mankind, but negative aspects also present potential increasing hazards. Some of the advances have created friction between governments, with threats of conflict. Although many organizations participate in disaster response, few have direct responsibility and plans and procedures to deal with emergencies.

19636 (LA–11728-C, pp. 41-53) **Nuclear power in the context of global warming.** Bodansky, D. (Univ. of Washington, Seattle (USA)). Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

The paper examines the extent to which nuclear power could help ameliorate the greenhouse problem. Topics discussed include: (1) How serious is the environmental threat posed by the greenhouse effect? (2) How large a part do fossil fuels play in producing greenhouse gases? (3) Is it possible to prevent or abate the anticipated global warming? (4) Can nuclear power play a significant role? (5) What overall approached might best reduce greenhouse emissions? Global cooperativeness in addressing the problem will be essential. 14 refs., 5 tabs.

19637 (LA–11728-C, pp. 65-70) **From militarism to environmentalism: A new focus for US-Soviet relations.** Brown, G.E. Jr. Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

This paper provides briefly discusses the unsuccessful history of US and Soviet scientific cooperation, and the recent changes in the political climate. Efforts to confront global environmental threats could become a fundamental defining character of relations between super powers, contrary to military focus in the past. Energy and environmental protection could play a pivotal role in helping achieve a substantial redifinition of the future US - Soviet relationship. The threat of global warming is discussed along with the role of NASA to obtain information in the Global Change program.

19638 (LA–11728-C, pp. 71-91) **Nonlinearity and chaos: The challenges and limitations of mathematical modeling of environmental and socio-political issues.** Mayer-Kress, G. (Univ. of California, Santa Cruz (USA)); Campbell, D.K. Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

The authors discuss the extent to which recent improvements in their understanding of inherently nonlinear phenomena present challenges to the use of mathematical models in the analysis of environmental and socio-political issues. In particular, the authors

demonstrate that the deterministic chaos present in many nonlinear systems can impose fundamental limitations on their ability to predict behavior even when precisely defined mathematical models exist. Since their primary aim is didactic, they make no attempt to treat realistic models for complex issues but rather introduce a sequence of simple models which illustrate the increasingly complicated behavior that can arise when the nonlinearity is properly taken into account. They begin with the familiar elementary model of population growth originally due to Malthus and indicate how the incorporation of nonlinear effects alters dramatically the expected dynamics of the populations. They then discuss two models which are caricatures of two issues - weather prediction and strategic/economic competition - of considerable importance to the general problem of technology-based confidence building. For certain ranges of their parameters, these models exhibit deterministic chaos, and they discuss how this behavior limits their ability to anticipate and predict the outcomes of various situations. Finally, they close with a few remarks on their general theme, stressing that despite its limitations and because of its challenges mathematical modeling of complex environmental and socio-political issues is crucial to any efforts to use technology to enhance international stability and cooperation. 58 refs., 6 figs.

19639 (LA–11728-C, pp. 92-97) **Nuclear waste: An agenda for US-Soviet cooperation on a vexing global problem.** Carter, L.J. Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

The paper speaks to opportunities for the United States and the Soviet Union to mount international initiatives to help the world cope with its growing accumulations of spent reactor fuel and high-level waste. Important new initiatives in spent fuel and waste management could be centered partly in or near sites long used for testing nuclear weapons, and be subjected to IAEA inspection and safeguards. In addition to an international storage center, a new center dedicated to research and development is proposed to be aimed at reducing geologic isolation of spent fuel or high-level waste to a routine that offers predictable and acceptable results. 10 refs.

19640 (LA–11728-C, pp. 98-101) **Designing effective protection against threats at nuclear facilities.** Cummings, G.E. (Lawrence Livermore National Lab., CA (USA)); Al-Ayat, R.A. Los Alamos National Lab., NM (USA). Nov 1989. DOE Contract W-7405-ENG-48. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

To build confidence in the viability of nuclear fission power, the public and governmental agencies must be assured that facilities handling nuclear material are adequately protected against a spectrum of hypothesized threats and their potential consequences. Two types of threat are discussed: The threat of a malevolent act, such as theft or sabotage, and the threat from natural or man-made hazards, such as earthquakes and fires. Designing protection in a cost-effective and demonstrable manner is becoming increasingly important. 6 refs.

19641 (LA–11728-C, pp. 120-122) **Global warming and energy use.** Domenici, P. Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

The paper discusses concerns regarding population growth and the world environment, particularly global warming. Steps are proposed for reducing the rate of the future carbon-dioxide accumulations and expanding the United States and International efforts to this end.

19642 (LA–11728-C, pp. 153-160) **Comparative analysis of mass forest and nuclear fires.** Ginzburg, A.S. (Institute of Atmospheric Physics, Moscow (USSR)); Golitsyn, G.S. Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

The massive forest fires that occurred in Siberia in 1915 are analyzed for the effects on regional and global climates in order to depict the impact of forest fires generated from war time use of nuclear weapons. The mathematical equations depict the index of danger conditions for starting forest fires and the resulting atmospheric conditions generated. 18 refs., 3 figs.

19643 (LA–11728-C, pp. 180-183) **An international agenda for enhanced nuclear safety and performance.** Hansen, K.F. (Massachusetts Institute of Technology, Cambridge (USA)). Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

Nuclear power represents 17% of the world's electric energy generated in 1988, and this fraction will continue to grow for the remainder of this century. Today, 26 nations have made major commitments to the nuclear option and in 13 countries nuclear power is over one-third of their electric capacity. In France and in Belgium, nuclear power represents about 70% of their capacity. The importance of this technology to the worldwide economy and environment is enormous and may grow more so in the future. The potential limitations to further development and deployment are not due to excessive costs, inadequate demand, alterative technologies, nor technological barriers to design, or operators of our current plants. Public confidence in nuclear power was shaken by the Three Mile Island accident, and the public became outspoken after the Chernobyl event. Another accident on a similar scale will be the death knell of nuclear power. Instantaneous shutdown of all plants is not likely, although there will be agitation for just that. What will happen is that a widespread conclusion will emerge that fission technology is too dangerous a technology and all further electric generation should come from nonnuclear sources. It is easy to identify particular nations where public concern is most volatile. Sweden is operating today with a plan to phase out their nuclear plants. The industries in the Federal Republic of Germany and in the United States are at a standstill. Public concern and awareness is felt in many other nations. We are in a situation where every single nuclear plant in the world holds every other plant as a hostage. The impact of another accident is not limited to local or national boundaries.

19644 (LA–11728-C, pp. 205-211) **Rethinking open skies in the information age.** Katula, R.L. Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

Remote sensing of the Earth is a technological breakthrough that involves everyone from the social scientist to the physicist and engineer. Therefore, all have a role in seeing that remote-sensing policies properly address the global challenges of our time. Discussing the implications of a revised Open Skies policy also fits in nicely with the emphasis of this conference: technology-based confidence building for energy and environment. Information gathered by remote-sensing satellites can increase confidence between governments and people by identifying common values and common solutions. Finally, Open Skies is a timely subject to discuss thanks to the revisiting of this concept by Preside Bush. In a recent speech on US-Soviet relations, the President suggested that the free over flight of reconnaissance aircraft, the essence of President Eisenhower's proposal, could promote greater openness in the Soviet Union and help stabilize the US-Soviet relationship. While only

34 years have passed since an American President first proposed Open Skies, it interesting to note the tremendous changes that have taken place on a global basis. I would like to suggest that changes in the geopolitical landscape during the last 34 years, along with advancements in satellite remote-sensing and associated information technology, have created new possibilities for national and global security through a revised Open Skies concept. In one sense, the potential to increase international security and stability through an Open Skies policy has in many ways been demonstrated.

19645 (LA–11728-C, pp. 212-224) **Economic and political implications of climate change.** Kellogg, W.W. (National Center for Atmospheric Research, Boulder, CO (USA)). Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

There is now virtually unanimous agreement in the climatology community that a future climate change as a result of human activities is inevitable and that it is undoubtedly already taking place. There has been an 0.6 to 0.8 K increase in the global average temperature in the past 100 years, and the most likely explanation for this trend is the increase in concentration of certain infrared-absorbing gases in the atmosphere so-called greenhouse gases. The most important of these greenhouse gases up to now is carbon dioxide, but methane, nitrous oxide, the chlorofluorocarbons (CFC's), and others may become important contributors to the warming in the decades ahead. The increase in these trace gases in the atmosphere has been due to human activity, primarily the burning of fossil fuels and (to a lesser degree) certain agricultural practices. The concentrations of these gases has been monitored for many years, and it has even been possible to extend the record back in time by analysis of atmospheric samples captured and locked in the ice sheets of Greenland and the Antarctic—samples whose age extends back to a period long before the intervention of mankind. If we wonder how fast this buildup of the greenhouse gases will take place in the future, we must ask what the future course of energy use will be. Will we continue to increase the rest of use of fossil fuels at 2% per year? Will we learn to use energy more efficiently and thereby decrease our consumption? Will we resort to nonfossil renewable energy sources or nuclear energy that do not produce carbon dioxide? The largest increase recently in fossil-fuel use has been in the developing countries, and we may ask: can they afford to continue this expansion into the next Century? A related question of even more basic importance is: will they be able to bring their population explosion under control?

19646 (LA–11728-C, pp. 225-233) **Cooperative, multidisciplinary problem solving for chemical accidents.** Koopman, R.P. (Lawrence Livermore National Lab., CA (USA)). Los Alamos National Lab., NM (USA). Nov 1989. DOE Contract W-7405-ENG-48. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

The manufacture, transportation, and use of hazardous chemicals is increasing worldwide and with this increase also comes an increase in the frequency of serious chemical accidents. In addition, increasing, population and population expansion around existing chemical facilities means that the consequences of these accidents are becoming more severe. In the twenty-four member countries of the Organization for Economic Cooperation and Development (OECD), which includes most of the chemical manufacturers, over 200 chemical accidents causing significant damage to human health, environment, or property occur each year. In the US alone, EPA has recorded at least 6928 accidents with acutely toxic chemicals in the last five years. These accidents killed 135 and injured nearly 1500 people. Compared to other industries, the chemical industry had an excellent safety record. It ranked second safest of 42 industries polled in 1986 according to National Safety Council statistics. Yet 44% of those responding to a recent Chemical Engineering (October 10, 1988) survey said their plants have had a major accident within the last five years, and 70% of these think that a similar accident could happen again. The tragic methyl isocyanate release in December 1984 at Bhopal, India, where approximately 3000 people died and 50 000 were permanently injured, has shown us that the consequences of an accidental chemical release can be unacceptably severe. A list of 10 major chemical accidents that have occurred in the last 14 years is given in Table I. At least 30 principal accidents (those having at least 100 persons dead, or 35,000 evacuated, or 70,000 without drinking water) involving hazardous substances have occurred between 1974 and 1988. The number of such accidents has diminished in OECD countries since 1983 but has increased rapidly in the developing countries. Causes are also discussed. 11 refs.

19647 (LA–11728-C, pp. 241-252) **Confidence-building and the Third World environmental challenge.** Lipschutz, R.D. Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

As the largest consumers of raw materials, producers of greenhouse gases, and exploiters of Third World instability, the two superpowers have a major responsibility to address and ameliorate the consequences of their policies there. The economic interests and connections between the industrialized world and the developing South are obvious and likely to grow in importance in the future, even for the Soviet Union. Cooperative efforts are worth initiating if they can eliminate potential sources of future conflict and instability and can assist Third World states in their efforts to achieve sustainable development. If cooperation can also take place in formerly contested regions of the world, uncertainty about each other's intentions and motives can be reduced. A few prescient analysts recognized long ago, in some of the chilliest years of the Cold War, that the most intractable threat to peace on the planet would turn out in the long run not to be the ideological confrontation between East and West per se but rather the stresses arising from failure to secure the material ingredients of a decent existence for substantial segments of the world's population. An impressive size of effort is likely to be needed to provide a decent chance of avoiding a potential exacerbation of international tensions–both by bringing under control the driving forces behind global environmental degradation and by building up the environmental, technological, and socio-political basis for a sustainable prosperity in North and South alike. A major redirection is required of the scientific, technological, and organizational resources of the planet, in which full East-West cooperation will be essential. Continued bickering about what is left of the US-Soviet ideological dispute is a silly distraction, and the diversion of a trillion dollars per year of the world's economic product into armaments is an intolerable handicap. 54 refs., 1 tab.

19648 (LA–11728-C, pp. 253-255) **Chemical accident preparedness and prevention: Past, present, and future perspectives.** Makris, J. Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

It was over four and one half years ago that methyl isocyanate (MIC) was accidentally released from the Union Carbide facility in Bhopal, India, resulting in a terrible disaster that killed more than 2,000 people and injured thousands of others. The United States and many other countries are still experiencing some of Bhopal's social fallout. This incident has changed the way the United States deals with accidents involving hazardous chemicals. The American public began to ask and continues to ask questions. Could it happen here? What can we do to prevent it? If it does occur, what should we do to protect ourselves? In response to this concern, the Administrator of the US Environmental Protection Agency immediately developed the Air Toxic Strategy, a broad strategy that addressed both accidental and routine releases of hazardous

chemicals. The portion of that program concerning the accidental releases became known as the Chemical Emergency Preparedness and Prevention (CEPP) Program. The CEPP Program recognized that the basic responsibility for understanding risks to localities, for trying to lower those risks, and for responding to an event if it occurs, must take place at the lowest level of government. The program encouraged local response personnel, chemists, scientists, risk evaluators, and physicians to work together both before and after an accident occurs. Analysis of the incident at Bhopal indicates that many lives could have been saved if the public had been prepared for an MIC release. The goal of the CEPP Program has been to highlight the need for preparedness and prevention to protect lives. Concurrent with the CEPP effort, the Chemical Manufacturers Association (CMA) was designing a program called Community Awareness and Emergency Response (CAER).

19649 (LA–11728-C, pp. 256-259) **Global change.** Malone, T.F. (St. Joseph College, West Hartford, CT (USA)). Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

Three theses are outlined that are relevant in setting a discussion of global change and our common future. (1) We are rapidly approaching the end of the five-century era within which the ebb and flow of military might and economic strength have been the key determinants in the rise and fall of the great powers. This era was brief. (2) The fundamental driving force of exponential expanding populations and related production and consumption factors. (3) The role and responsibility of the scientific and technological community.

19650 (LA–11728-C, pp. 266-274) **Mission to planet Earth.** McLucas, J.L. Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

National leaders are taking notice of the importance of the topic, and it is the subject of discussion at meetings of heads of state. Whereas only a few years ago, most people were not concerned about the environment, recent public opinions show that 3/4 of the people in the US regard it as a primary concern that demands more attention than it is getting. Many have gone even farther in their thinking, to the point that they think we are in a serious environmental crisis. It is possible that the air of crisis is doing us a favor. It presents the people of all the Earth with the threat of a common danger. It is usually easier to elicit people's cooperation in facing a common danger than it is to get them to cooperate on some worthy but altruistic purpose. Because of the threat, there is a surprising degree of consensus that the problem is real, that we must change not only our ways of behaving but our ways of thinking about our world. There is also a feeling that we used both new policies and new leadership from the top to deal adequately with what faces us. All of this leads me to consider how we can use our space assets to improve our knowledge and equip us to deal with the environmental challenge. Mission to Planet Earth refers to a continuing study of the Earth from space. One of the principal points of this paper is that space is the place to gather most of the data we need to understand the Earth for the first time in all its beauty, glory, and increasingly recognized vulnerability.

19651 (LA–11728-C, pp. 278-286) **Commercial satellites and national security.** Nacht, M. (Univ. of Maryland, College Park (USA)). Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

We are clearly witnessing a revolution in communications technology, of which the commercial availability of remote-sensing satellites is one dramatic manifestation. The question to be addressed in this paper is the following: What will be the likely effects of the information provided by these satellites governmental decisions (especially the US government) related to national security in general and crisis situations in particular? Although the public debate on this issue is only in its infancy, two perspectives, diametrically opposed are already beginning to take shape. The first–the revolutionaries–conclude that high-resolution commercial satellites have irrevocably broken the monopoly of remote-sensory information held until now between the United States and Soviet governments. With many players likely to gain access to this information the ability of the superpowers to conduct classical crisis decision-making in secret will be lost forever. Relations with allies will consequently become far more complex and the role of the news media will even greater than at present in influencing governmental and public perceptions of international events. The second perspective–held by the traditionalists–is highly skeptical of the conclusions of the first. Those holding this view argue that Washington and Moscow, and a few other major governments to a less extent, possess a multiplicity of intelligence sources that far exceed the capabilities of commercial satellite. These source are discussed. 7 refs.

19652 (LA–11728-C, pp. 287-291) **Some political problems on global climate change.** Quester, G.H. (Univ. of Maryland, College Park (USA)). Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

The state of human capabilities on predicting, and possibly modifying, our weather and climate does not lend itself to easy generalization. It is still typical for the man on the street to scoff at most of meteorology, ticking off all the times when the weather forecast seemed to be wrong and when the Farmer's Almanac was allegedly right. Such spurious folklore aside, however, tremendous strides have indeed been made in weather analysis and weather prediction, by the harnessing of satellites and computers and the simple accumulation of scientific knowledge. With this ability to predict future weather has also come a better understanding of man's impacts thus far on climate and weather and hence also the possibilities now of a deliberate, rather than inadvertent, modification of this climate; and with this can come a host of new political conflicts. Whenever man understands the linkage, he can then be deliberate about it; when he can be deliberate, he gets into new arguments. With regard to deliberate modification of climate, some definite successes had already been achieved on a more local or microcosmic level for four or five decades, in the artificial inducement of rainfall and the clearing of fog. Such success stems from the exploitation of local catalytic or triggering effects in which a small input of material or energy induces changes of much larger magnitudes in the weather. Not so surprisingly, even such first minor uses of weather-modification techniques have then brought an aftermath of numerous lawsuits within the domestic courts of the countries involved. Impact, control and precedents of causality and conflict are discussed.

19653 (LA–11728-C, pp. 292-297) **Antarctic research: Importance for global change.** Reck, R.A. (General Motors Research Labs., Warren, MI (USA)). Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

General circulation climate-modeling calculations suggest the Antarctic continent may serve as an early warning system for future global changes. Model results show increases in greenhouse gases will cause climatic heating, which is magnified many times in the polar regions. Global surface temperature measurements show a rise of 0.08 C per decade since 1958, but, in the polar regions only, there was slight decrease in measured temperatures from 1973 to 1987. For these reasons the Antarctic climate has become

an especially important focus of scientific efforts. Antarctica constitutes 10% of the land area of the globe (which is about 1.5 times the size of the united States), is the coldest continent on earth, and is surrounded by three oceans. Ninety-eight percent of Antarctica is permanently covered by ice and 90% of the world's ice is contained on the continent. Thus this land-supported ice is especially significant for global change since decreases in its abundance would directly alter the sea level, causing inundation of coastal regions. The Antarctica remains a vast expanse to be used for peaceful purposes only, with complete freedom for scientific investigation. Territorial claims are held by Argentina, Australia, Chile, France, New Zealand, and the United Kingdom. There were 12 countries (with 60 research settlements, see Figure 1) that signed the original Antarctic Treaty and, since 1961, it has remained as a commonly-held heritage for all people. Because of the force of global change, this common heritage may be altered significantly. This gives an additional incentive consideration of the region. The uniqueness of the region and recent research findings are discussed. 18 refs., 3 figs.

19654 (LA–11728-C, pp. 298-301) **Understanding global change: The International Geosphere-Biosphere Program.** Reck, R.A. (General Motors Research Labs., Warren, MI (USA)). Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

Our species has always struggled with a widely diverse and ever-changing environment. These changes are the result of massive forces that continue to change the environment of the earth even to this day. Along with these large and often slow natural changes, human development has created rapid changes of the earth's surface, mainly so that modern society can survive, develop, and prosper. An analysis of the earth's surface from a satellite-view perspective shows large metropolitan settlements with extensive energy usage (light spots in the night sky), huge industrial complexes, gigantic water control systems, coast-to-coast highway infrastructures, and significant decreases in the number of biological species, their location, and range. Not only has our global surface changed, but many other factors that contribute to a global balance, including such important contributions as the trace greenhouse-gas constituents of the atmosphere and the abundance and distribution of ground water. It is only in recent times, that significant human-caused changes have become possible or necessary. The capabilities of satellites, global communication, and megacomputers can be combined to rapidly yield access to enormous information banks, which relate many overlapping areas of knowledge about the globe. Without modern electronics and remote sensing, these information banks would take hundreds of man-years to develop, thereby making the acquired knowledge relatively worthless for rapid prediction capabilities. It is through modern technology that it becomes possible for scientists to undertake global-scale studies to document the full changes of the earth and to attempt to sort out the relative contributions of human activities. Organization of an international program is discussed. 4 refs.

19655 (LA–11728-C, pp. 275-277) **Inherent safety in nonnuclear applications.** McQuaid, J. (Health and Safety Executive, Sheffield (England)). Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

The concept of inherent or passive safety is receiving considerable attention as the basis for the design of the next generation of nuclear power reactors. There is a tendency to speak of the concept as representing advanced technology. The purpose of this paper is to caution against such an association. The paper examines examples of the application of the concept, some of very long standing, outside the nuclear arena and reviews the impetus given to its development in the chemical industry as a result of the major explosion at Fixborough, UK, in 1974.

19656 (LA–11728-C, pp. 302-308) **Energy-technology R and D: What could make a difference?.** Reister, D.B. (Oak Ridge National Lab., TN (USA)). Los Alamos National Lab., NM (USA). Nov 1989. DOE Contract AC05-84OR21400. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

Two major uncertainties cloud the future energy system: the level of energy demand and the consequences of the greenhouse effect. Energy-technology R and D provides technological alternatives for the future energy system. The Oak Ridge National Laboratory (ORNL) recently completed a broad survey of energy-technology R and D. The survey revealed a rich variety of options for both end-use technologies and energy supply technologies. However, none of the nonfossil energy sources are ready to substitute for fossil fuels at the scale necessary to mitigate the potential consequences of the greenhouse effect. 1 ref.

19657 (LA–11728-C, pp. 309-317) **International scientific cooperation in the Arctic.** Roederer, J.G. (Univ. of Alaska, Fairbanks (USA)). Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

Cooperative scientific research in the Arctic plays a particularly important role in confidence building among the nations of the circumpolar north - which include the two superpowers. The Arctic is a very special region from many points of view: (1) it is a most sensitive early warning system for global climate change; (2) it is in itself an important participant in the control of global change through its active links to the world oceans and the total atmosphere; (3) it is one of the least understood components of our planet; and (4) it is a most important region from an economic and strategic point of view. There is a great demand for scientific research, which by necessity must be international - yet international cooperation in the Arctic is most difficult. This article describes these difficulties and discusses newly emerging opportunities in the light of recent positive international developments. 9 refs., 1 tab.

19658 (LA–11728-C, pp. 318-323) **Relevance of international research facilities to international stability.** Rosen, L. Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

International facilities have played an important part in expanding and keeping open a dialogue between east and west. The advent of glasnost has dramatically reduced inhibitions on communications and opened new opportunities for international facilities to facilitate the understanding and appreciation of common goals and common threats. This is accomplished through frank discussions in which real problems are identified and assessed while fictitious ones are laid to rest. Concerns about energy, the environment, economic security, raw materials availability, etc., require more effective international cooperation. Scientific facilities have provided a training for such joint enterprises, in both the technical and sociological spheres. Finally, international science facilities can to bridge the chasm the experts and the nontechnical community, because the support of these facilities requires describing the purposes and goals and hopes of science to the general public, which must bear the burden of their support just as it enjoys the fruits of their progress. It therefore appears that we should now consider greatly increasing our investment in international facilities to specifically address not only basic research but also practical issues, such as environmental pollution, energy production, resources depletion, weather modification, defense against terrorism, space exploration, and, of course, agricultural technology. A final example: it appears that far too little attention has been given to the role of the oceans in the ecology of our planet. If we define coastal areas as 2 miles

in depth, we see that well over half of the world's population resides in just those areas. Global temperature changes of not many degrees have the potential for producing havoc. Is there a more important long-term goal than to understand that issue? Does it not merit a major international initiative? Even a major international facility.

19659 (LA–11728-C, pp. 324-331) **The internationalization of nuclear safety.** Rosen, M. (International Atomic Energy Agency, Vienna (Austria)). Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

Nuclear safety is interlinked in many ways with the themes of this conference. In searching for co-operative activities that touch on global energy and environmental problems and on initiatives that relieve international tensions, the ongoing developments in nuclear power safety offer a number of successful examples. Commercial nuclear power has been with us for more than 30 years, and with 26 countries operating plants in addition to 6 more constructing their first, there has been an ongoing global co-operation, coinciding of Chernobyl with Glasnost, along with the increasing awareness of the benefits of common solutions to safety issues, have brought about an internationalization of nuclear safety. Although the main responsibility for safety rests with each operator and its government, a primary driving force expanding international co-operation is the transboundary aspects of nuclear energy, as vividly demonstrated by Chernobyl accident. In this presentation we focus on the mechanisms already in place that foster cooperation in the nuclear safety area.

19660 (LA–11728-C, pp. 332-337) **US-USSR collaboration in high energy physics.** Rubinstein, R. (Fermi National Accelerator Lab., Batavia, IL (USA)). Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

High-energy physics is the study of the basic structure of matter and the forces involved between the constituents. It is pure fundamental research with no immediate military or commercial significance; results are published in the open scientific literature. Because of this, it is an ideal field for international collaboration. At Fermilab, for example, there are typically about 1300 physicists and graduate students on our approved experiments at any time, of which some 400 are from institutions outside the US, from about 20 countries. High-energy physics experiments are carried out at accelerators, large central facilities at government funded national laboratories. There are a limited number of such facilities, due to their large cost– Fermilab cost about one quarter of a billion dollars twenty years ago. The research is carried out largely by professors and their students from universities. The size of research groups varies from one or two people to about 300 scientists, together with engineers and technicians, on a $100 million detector, with the experiment lasting a total of about ten years. A research group is composed of up to 30 university subgroups, each responsible for a piece of the detector or software, with all subgroups sharing in the physics results. The subgroups get together to carry out an experiment because of a common interest in the physics goals; this leads to collaborations with physicists from many countries. The experiment is carried out at the accelerator that best suits the experiment, in whichever country it is located. Some years ago the directors of the major laboratories issued a statement that the criteria for acceptance of a research proposal are the scientific merit and technical competence of the proposal; note that there is no mention of the country of origin of experimenters.

19661 (LA–11728-C, pp. 343-348) **Building confidence through US-Soviet scientific exchanges.** Schweitzer, G.E. Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

To arms-control specialists, the term confidence building has a distinct connotation based on years of effort in formal and informal arms control arenas to develop approaches that reduce the suspicions of the US Government and, to a lesser extent, the concerns of the Soviet Government, over hostile intention of the opposing superpower. Many types of East-West confidence-building measures have been considered in addressing these over lapping goals. Among those now incorporated in agreements are the communications hot line between leaders of the United States and the USSR, the procedures for warning of accidental launches of strategic weapons and for notification of exercises of conventional military forces, and the verification provisions o the ban on intermediate-range nuclear weapons (INF Agreement). Other approaches that have also been proposed by Soviet or American scholars include nuclear-free zones, restraints on naval activities near coastal waters of an adversary, and a demilitarized corridor in Central Europe. Given the closed nature of Soviet society, least until very recently, the US Congress, as well as the Executive Branch, has enthusiastically embraced this concept while American officials press hard in many international forums to reach agreement that would illuminate Soviet activities and thereby clarify their intentions. The contribution of scientific exchanges and benefits to arms control and the changing concept of military power and national security are discussed.

19662 (LA–11728-C, pp. 349-354) **Opportunities for US-USSR cooperation in the investigation of Arctic stratospheric ozone.** Sheldon, W.R. (Univ. of Houston, TX (USA)). Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

The model of the polar atmosphere that has been developed to account for the Antarctic ozone hold is described, and the northern polar region is shown to be equally vulnerable to episodes of significant ozone depletion, if only very small changes were to occur in Arctic weather patterns. In situ investigation of the stratosphere north of the Arctic circle was the focus of several major campaigns conducted in early 1989. The results of these efforts are recounted briefly, with emphasis on the CNES stratospheric balloon campaign at Esrange in January 1989, an expedition which provided observations of the initial phase of an ozone hole. Northern polar atmospheric circulation patterns are shown to behave such that ozone hole formation was terminated at an early stage in 1989. However, the point is made that conditions in the northern stratosphere are perilously close to creating an Arctic ozone hole as large as any observed in the southern hemisphere. The result could be an ecological disaster north of latitude 65°, with the greatest probable threat to Scandinavia and the USSR. Possible cooperative research programs with the USSR to investigate relevant aspects of the polar stratosphere are discussed. 13 refs.

19663 (LA–11728-C, pp. 355-374) **Nuclear power and east-west European cooperation.** Silvi, C. Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

Nuclear energy development in all of Europe, East and West, has been adversely affected by the Chernobyl accident of 1986, which provoked new concern about the safety of nuclear power plants. Parallel to their efforts to improve the safety of the present generation of nuclear reactors, European countries are now also exploring new technological solutions for their future nuclear power. In the past, nuclear power in Eastern Europe developed within the framework of COMECON, under the leadership of the Soviet Union, while in Western Europe it has developed on a national basis. Interaction between Eastern and Western European nuclear

programs has been negligible. In the future, however, growing international cooperation will probably affect European nuclear power as well as other areas; the programs of Western European countries will be less marked by nationalism and there will be closer ties among Eastern and Western European countries. The topics discussed are: nuclear power developments in Eastern and Western Europe; prospects for international cooperation in Europe; prospects for future nuclear power, prospects for cooperation among Eastern and Western European countries. 68 refs.

19664 (LA–11728-C, pp. 375-384) **Highlights of 50 years of nuclear fuel development.** Simnad, M.T. (Univ. of California, San Diego, La Jolla (USA)). Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

The development of nuclear fuels since the discovery of nuclear fission is briefly surveyed in this paper. The fabrication of the uranium fuel for the first nuclear pile, CP-1, is described. The research and development studies and fabrication of the different types of nuclear fuels for the variety of research and power reactors are reviewed. The important factors involved to achieve low fuel-cycle costs and reliable performance in the fuel elements are discussed in the historical context. 10 refs.

19665 (LA–11728-C, pp. 385-394) **Vulnerability analysis for airborne accidental release of hazardous chemicals.** Singh, M.P. (Indian Institute of Technology, New Delhi (India)). Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

The paper deals with the development of a heavy-gas-dispersion model, which has been used to prepare a chart or nomogram, that gives safe distances in the case of accidental release of chlorine. The nomogram is based on quantity released and meteorological conditions. The meteorological scenario for the whole year has been subdivided into 24 categories, which are easily discernible to a layman so that the nomogram can be used in emergencies (arising from accidental release of Cl_2 by employees working at a plant where chlorine is stored in large quantities). 2 refs., 1 fig., 1 tab.

19666 (LA–11728-C, pp. 338-342) **US-USSR cooperative effort in radioactive high-level waste management.** Schoderbek, S.E. (BDM International, Inc., McLean, VA (USA)); Chabai-Burgett, P. Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

Confidence-building measures play a role in aiding to defuse crises and reduce the escalatory risks inherent in crises. By participating in confidence-building measures, nations enhance their national security. In the past, confidence-building measures have mainly operated in the political arena. However, there is a need to develop initiatives to function, not only in the political arena, but also in the social arena. This paper proposes a US-USSR cooperative effort in prototype disposal demonstrations, and in safety assessments of potential repositories for radioactive high-level wastes (HLW). It should be clear that this problem is a shared-interest problem for the following reasons: (1) No other nations employ as many nuclear reactors for the generation of electricity as the United States and the Soviet Union. The United States has 100+ operable commercial reactors producing 100 Gwe, which is 17 percent of the US total output. The Soviet Union has 50+ reactors producing 35 Gwe, or 11 percent of their total output. Both nations have over three decades of experience in nuclear generated electricity production, as well as three decades of attendant nuclear reactor wastes. (2) Because uranium and plutonium are also present in irradiated fuel (spent reactor fuel), those nations which produce nuclear materials for defense weapons have reprocessing facilities to recover these materials. The United States and the Soviet Union possess the largest quantities of nuclear weapons. In the United States, these Department of Energy uranium and plutonium recovery processes generate HLW in the form of an aqueous stream. These liquids are reduced in volume and some of the remaining materials must eventually be isolated from the biosphere until they have decayed to levels that will present no unacceptable risk, perhaps for as long as 100,000 years. 14 refs.

19667 (LA–11728-C, pp. 402-408) **US-Soviet collaboration in energy-conservation research and development.** Socolow, R.H. (Princeton Univ., NJ (USA)). Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

A US-Soviet collaboration in energy-conservation research and development, begun five years ago, has had considerable impact in both countries by identifying options in the energy system that can reduce adverse impacts on global climate and stresses in global energy markets. Highlights of the collaboration are reviewed, with particular attention to the component of the collaboration involving joint field experiments in energy efficiency in large apartment buildings. Arguments are set forth for the importance of obtaining the active participation of the Soviet research community in the formulation of strategies to develop an environmentally sensitive global energy policy. Going beyond the current collaboration, an Environmental Action Corps is proposed, focusing on targeted assistance to developing countries for the purpose of reducing adverse impacts on the global environment. The Environmental Action Corps could be either a unilateral US initiative or a coordinated multinational effort that might include the Soviet Union. In the latter case, the consultative processes already in place in the current collaboration in energy efficiency may be of use. 5 refs.

19668 (LA–11728-C, pp. 409-412) **A journalist's perspective: Lessons of the joint verification experiment.** Spohn, L. Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

Nearly one year ago, the globe's nuclear heavyweights squared off, in the desert of Nevada; not in confrontation, but to conduct a remarkable cooperative test called the Joint Verification Experiment. (JVE). The initial objective was to affirm two outstanding, but unconfirmed, US-Soviet nuclear test limitation treaties: The 1974 Threshold Test Ban Treaty and the 1976 Peaceful Nuclear Explosions Treaty. Underground nuclear explosions were limited to not more than 150 kilotons. While both nations say they have observed this limit, neither treaty was ever formally ratified or enforced. The hang-up had been verification due to lack of trust. The Soviets contended that distant seismographic techniques were adequate for the task; while the US insisted upon on-site verification. The JVE particulars were worked out in May 1988, barely six months after the two countries agreed to reopen negotiations on the two outstanding treaties. By agreement each would explode one of their nuclear bombs underground at their most secret nuclear proving grounds: First at the United States Nevada test site (NTS), on August 17; and a month later, September 14, at the Soviet Union's Poligon, near Semipalatinski. By all accounts each half of the experiment was a smashing success, literally. The verification systems produced the necessary data and generated highly optimistic official statements.

19669 (LA–11728-C, pp. 413-425) **Political factors in the development and implementation of technology-based confidence-building measures.** Steinberg, G.M. (Bar Ilan Univ., Ramat Gan (Israel)). Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA),

9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

The second half of the 20th century has been characterized by the continuous development and improvement of weapons of mass destruction, including strategic bombers, missiles, chemical and biological agents, and of course, a variety of nuclear weapons. In contrast to the massive change in military capabilities brought about by the rapid development of science and technology, international relations is still dominated by relations between sovereign nation states and characterized by distrust and narrow interests. At the same time that scientific developments created the foundation for the nuclear arms race, however the scientific and technical community has also sought some antidotes. Technology-based confidence building measures (TBCBMS), designed to reduce international conflict and to prevent nuclear war, have been proposed by scientists from the US and the USSR. These TBCBMS have taken a number of forms such as cooperative research and development programs, joint panels and meetings of professional societies, and specially dedicated international forums. These have provided a meeting ground for the exchange of views among scientists from many different countries. In addition, a number of more direct forms of TBCBMS, such as satellite-based observation systems and IAEA nuclear safeguards, have national technical means of verification. More recently, there have been a number of proposals to apply many of these technologies to verification of conventional force reduction, arms control, and other confidence-building measures in context of regional conflicts in the Third World. An International Satellite Monitoring Agency has bee proposed to develop space-based technologies such as observation satellites to increase stability and prevent the outbreak of accidental war in regional contexts such as the Middle East.

19670 (LA–11728-C, pp. 433-447) **Real-time global mutual aid for atmospheric releases of radioactivity is possible today.** Sullivan, T.J. (Lawrence Livermore National Lab., CA (USA)). Los Alamos National Lab., NM (USA). Nov 1989. DOE Contract W-7405-ENG-48. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

The Lawrence Livermore National Laboratory's Atmospheric Release Advisory Capability (ARAC) has developed and evolved a computer-based, real-time, radiological-dose-assessment service for the United States Departments of Energy and Defense. This service is built on the integrated components of real-time computer-acquired meteorological data, extensive computer databases, numeric atmospheric-dispersion models, graphical displays, and operational-assessment-staff expertise. The focus of ARAC is the off-site problem for which regional meteorology and topography are dominant influence on transport and dispersion. Through application to numerous radiological accidents/releases on scale from small accidental ventings to the Chernobyl reactor disaster, ARAC has developed methods to provide emergency dose assessments from the local to the hemispheric scale. With the improved computer size power and performance cost ratios, ARAC has expanded its service and reduced the response time from hours to minutes for an accident within the United State. Quality of the assessments has improved as more advanced models have been developed and incorporated into the ARAC system. Over the past six years, the number of directly connected facilities has increased from 6 to 73. All major US Federal agencies have access to ARAC as specified in the US Federal Radiological Emergency Response Plan, assuring consistency and experience. Real-time skills are maintained by participation in approximately 150 exercises per year; modeling systems are validated by application to all available tracer experiments and data sets. The most recent major application to a real accident event was the Chernobyl disaster, and ARAC was well prepared for the potential COSMOS 1900 reactor burn up. Preparation for events such as these provides the impulse for further improvement in data acquisition, databases, mapping, and models. 17 refs., 2 figs.

19671 (LA–11728-C, pp. 448-454) **National energy planning and confidence building between nations.** Sweedler, A. (San Diego State Univ., CA (USA)). Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

The main thesis of this paper is that the effects of energy production, distribution and consumption within national boundaries have serious repercussions in neighboring regions and, in some cases, in areas far removed from the source of energy use. This results in increased strains and tensions not only between nations but also within whole regions. By taking into consideration the regional and global ramification of national energy policies, governments could use energy planning as a means of building confidence between states. This, in turn, could create the political framework for improving and strengthening security arrangements, especially between adversarial nations or alliances. The past decade has witnessed a growing awareness of the regional and global effects of energy-related activities. Some well-known examples are the production of electricity from coal- and oil-fired plants in the United States and the resulting acid precipitation in Canada, which has created tensions between otherwise close allies. Plants in England and continental Europe have generated similar environmental problems in Scandinavia and have contributed to strains between nations in the region. Less well-known cases of adverse cross-border effects resulting from energy-related activities can found between the United States and Mexico and among the nations that share the Baltic Sea. These two cases are examined as examples of how coordination of energy planning or adjustments of nations energy policies to take into consideration regional concerns could enhance security by building confidence between states of the region. 11 refs.

19672 (LA–11728-C, pp. 455-463) **Environmental Perestroika: Energy technology and east-west confidence building.** Swisher, J.N. (Stanford Univ., CA (USA)). Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

For the first time in history, human activities are affecting the Earth's environment so greatly that they threaten to trigger changes in the Earth's climate through a gradual warming of the atmosphere (Greenhouse Effect). This process of global warming is the result of the combustion of fossil fuels, tropical deforestation, and other agricultural and industrial activities. By burning fossil fuels, every nation emits some portion of the greenhouse gases that contribute to global warming, and nearly every nation is likely to be adversely affected by changes to the Earth's climate. The US and the USSR are the largest contributors to the global warming problem, although Soviet energy consumption has been growing at a much greater rate than US energy use, which has become far more efficient since 1973. Both nations, and the rest of the world as well, stand to benefit from increased cooperation to alleviate this common environmental problem, principally through West to-East technology transfer. Reducing global environmental threats, such as that of climate change, can significantly enhance the long-term national security of many nations, including the superpowers. Moreover the international communication and cooperation that are required to implement these and other measure to protect the global environment provide an opportunity for East-West confidence building. Emerging strategies, such as those that improve energy efficiency, can help reduce fossil-fuel us and alleviate the climate-change problem, and these technologies promise economic benefits as well. These technologies can reduce the capital demands of the Soviet energy sector, and they represent a potentially large market for international trade. Trends of Greenhouse-gas emissions, energy economy, efficiency and security issues are discussed. 21 refs.

19673 (LA–11728-C, pp. 464-470) **International carbon emission offsets: A tradeable currency for climate protection services.** Swisher, J.N. (Stanford Univ., CA (USA)). Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

Reversing the trend of tropical deforestation would provide many ecological benefits, including slowing the rate of global climate change, which is being caused in large part by carbon-dioxide emissions from fossil-fuel use. While the responsibility, the technology, and the financial resources for reducing carbon emissions are all concentrated in the industrialized nations, much of the potential for reducing future emissions is in the developing nations. Thus, successful solutions to the climate problem will likely require significant transfers of resources, including debt relief, from North to South. If one or more industrialized nations agree to reduce their contribution to global carbon emissions, these nations will need to adopt policies to achieve the reductions. Market-based policies, such as carbon-emission taxes or tradeable emission permits, would assign a monetary value to reducing atmospheric carbon. Similarly, an international market mechanism for trading climate protection services worldwide would impart this value to investments in measures such as afforestation or energy efficiency, allowing carbon emitters to seek the least expensive ways to reduce emissions. International carbon-emission offsets (ICEOS) could provide such a mechanism, by creating a currency or investing in carbon-saving services as a way to comply with national policies. The opportunity to sell these services as ICEOS, or to trade them for debt relief, would give the developing nations a tangible economic incentive to use clean energy technologies and to protect their forests, rather than to deplete them. Instead of having to choose between economic development and environmental protection, Third World nations would find themselves endowed with a valuable export commodity in the environmental services from their forested or potentially-forested lands. Economic and policy mechanisms are discussed. 16 refs., 1 fig.

19674 (LA–11728-C, pp. 471-473) **US Department of the Interior international cooperative research activities.** Watson, H.L. Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

The Department has an annual budget of about $6 billion and is the Federal Government's largest landowner: approximately one-fourth of the Nation's land mass is owned and managed by the Department. Interior might best be described as a holding company composed of 10 small corporations which, in one way or another, impact the lives of nearly every American on a daily basis. The scope and role of each agency is discussed.

19675 (LA–11728-C, pp. 474-477) **Nuclear energy, carbon dioxide, and international cooperation.** Weinberg, A.M. (Oak Ridge Associates, TN (USA)). Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

The greenhouse effect provides a powerful incentive to develop and deploy energy technologies that emit less carbon dioxide (CO_2) than do conventional fossil fuels. Controversy still surround the greenhouse effect: how large is the warming, when might the warming occur, how will the warming affect the distribution of rainfall and other weather patterns. One proposition, however, is incontrovertible the amount of CO_2 in the atmosphere has been increasing at the rate of about 1 part per million per year (i.e., about 3 gigatons/yr, GTC/y) ever since accurate measurements became available in 1958 and now stands at about 350 ppm. This corresponds to about 750 gigatons (billion tons) of carbon (as CO_2) in the atmosphere. A second proposition, though less certain, is of great importance. The natural fluctuations in the Earth's ambient temperature have been tracked for the past millennium from observations of the ratio of O^{18} to O^{16} in Greenland ice cores. Temperatures of the Earth began to diverge from the natural fluctuations revealed by the Greenland ice cores in the past 40 to 50 years. The measured temperatures in this recent period have been higher than the expected natural fluctuations. This observation is consistent with a greenhouse warming but, of course, does not prove the warming is a consequence of greenhouse. Third, we ought to reforest since possibly as much as 1-2 GTC/yr is released from the destruction of the tropical forests. Finally, we must get on with the nonfossil energy sources: biomass, fission, fusion and solar. 1 tab.

19676 (LA–11728-C, pp. 486-492) **Air quality studies in the western United States.** Yamada, T. Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

There are several on-going air quality studies in the western United States. These projects have their own objectives and focused on specific areas of interest. There are, however, some objectives common to all the projects. They are: (1) To quantify the source/receptor relationship, i.e., to estimate how much each source contributes to the pollutants distribution, and (2) To develop a data base for testing, evaluating, and improving air quality simulation models. Highlights from the measurement program are given, along with models and results. 7 refs., 6 figs.

19677 (LA–11728-C, pp. 493-497) **A desk-top computer forecast for emergency response planning.** Bice, B. (Applied Computing Systems, Inc., Los Alamos, NM (USA)); Yamada, T.; Bunker, S.; Williams, M. Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

The purpose of the study is to demonstrate the feasibility of running a three-dimensional weather forecast model on a desk-top computer. For emergency response planning, the ability to forecast wind temperature, and atmospheric turbulence is essential in order to predict the transport and diffusion of accidental release of toxic materials. Most models for emergency response are based on the assumption that wind and turbulence condition at the time of the release will be representative over the period for which dispersion must be predicted. For small releases where the principal concern is within the first few kilometers of travel, such an assumption is appropriate. However, for large releases during stable conditions, the plume may travel for several hours and the assumption of persistence is invalid. Under these circumstances a model which can forecast change in wind and turbulence conditions is required. Persistence is a particularly poor assumption to make in mountain valleys and coastal locations. In coastal locations, we have land-sea breeze phenomena, whereas the mountain valleys we have the mountain valley wind system. In both instances abrupt changes in wind direction can be expected during the diurnal cycle, and the wind direction at a given time is very sensitive to the location where the winds are measured. A diagnostic model needs a large number of measurements in time and space to represent accurately the airflows in complex terrain. Such extensive measurements could become very expensive and are not practical. Diagnostic models, by themselves, are not adequate for emergency response management since they have little predictive capability. A forecast model, on the other hand, can forecast locally generated diurnal circulations driven by terrain features. Three-dimensional forecast models for practical applications and results are discussed. 6 refs., 2 figs.

19678 (LA–11728-C, pp. 498-502) **Nuclear energy, coal, and environment.** Yang Yin; Pan Ziqiang. Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment,

Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

From the view point of environmental protection, nuclear plants are superior to coal-fired ones. Coal-fired plants and other uses of burning create serious environmental problems, whereas no noticeable impacts are identified for nuclear plants. Even with respect to radiation risk, with equal energy output, a coal-fired plant is one order of magnitude higher than a nuclear station. Energy is a prerequisite for the development of a national economy and the improvement of living standards. Economic growth must be coordinated with the exploitation of energy resources. The worsening shortage of energy has made it imperative that China step up its energy development and pay full attention to the development of nuclear energy. Among direct energy sources, about 70% came from coal in the past. The public has been greatly concerned over the pollution caused by coal-fired power stations and/or other industrial and domestic use of coal burning. With increasing mining of coal, the issues related to pollution from the use of coal will become more serious and prominent. 17 refs., 3 tabs.

19679 (LA–11728-C, pp. 503-508) **The development of energy and its influences on the environment.** Zhou Yunhua; Wang DeLi; Zhu Jiaheng. Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

Energy consumption is increasing substantially as the world economy rapidly develops. The influences of energy development on the environment will become more conspicuous. Among them, pollution caused by burning fossil fuels draws the greatest attention from all nations. Some experts hold that, since the early eighties, a second upsurge of environmental concern has occurred because of the increasing environmental pollution and damage to the ecological balance on a large scale. The first environmental movement occurred between the fifties and the sixties. At that time, environmental pollution in industrialized countries was so serious that it threatened directly the life and security of people, exerted a tremendous influence on economic development, and caused serious social disturbances. Despite all these disadvantages, however, it appeared only in some factories and districts in those countries. Comparatively, both the pollution sources and their range were more limited. The United Nations held the Conference of Human Environment at Stockholm in Sweden at this time. It was a milestone for mankind to recognize the importance of and make efforts for environmental improvement. In the recent environmental movement, people are more concerned about problems that have an extremely harmful impact on large areas, including the problems of acid rain, ozonosphere destruction, greenhouse effects, etc. These problems attract a great deal of attention in countries all over the world. Concerned authorities in China have also begun to attach importance to these problems. This is especially true of energy consumption in China, as the main fuels in cities and large industrial bases coal and other fossil fuels, whereas 75 percent of the energy in the countryside is dependent on biomass energy. Such a pattern undoubtedly exerts a big influence on environmental pollution and undermines the ecological balance.

19680 (LA–11728-C, pp. 509-512) **Energy: The coin of international understanding.** Zucker, A. (Oak Ridge National Lab., TN (USA)). Los Alamos National Lab., NM (USA). Nov 1989. DOE Contract AC05-84OR21400. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

Energy and agriculture have been the technological hallmarks of civilization from its dimmest beginnings. The myth of fire stolen from the gods recounts the first ever technology transfer activity, and it quite rightly focuses on energy. Even that myth foreshadows the ambivalence mankind has always exhibited toward fire. There is a price to pay for the possession of fire. Fire, the good servant and evil master. Don't play with fire. How deeply energy is engraved in human consciousness. Now, with a world of five billion souls and heading for double that number, energy commands center stage. Everybody uses, mistrusts, needs, wants, loves, hates, and fears some aspect of energy. Rich poor, north and south, capitalist and ancialist, humanist and fundamentalist—all deal with energy in most intimate way. The price of oil has an immediate effect on the economy of the West, it can start stop development in the third world, it leads to wars, it determines the size of cars in Japan, and create bizarre cities on stilts in the hostile North Sea. Energy is the great benefactor: it relieves drudgery, it makes agriculture productive, it gives us light and heat. The great dream of every young person in the US is to own that certain car. The same dream that informs the citizens of the third world, that leads to impenetrable traffic jams in Mexico City, in Nairobi, in Shanghai, but not yet in Moscow or Riev. No doubt the unsuspecting Russian will judge perestroika to have been successful when there is gridlock on Pushkin Street. Energy is the great polluter: smog, carbon dioxide, acid rain, islands of heat, melting permafrost, a nuclear waste. Indirectly energy fuels all the other forms of pollution: agricultural waste, pesticides, little bits of polystyrene, the huge amounts of just plain trash in search of a final resting place. Aspects of energy that characterize its uses by society are discussed.

19681 (LA–11728-C, pp. 513) **Concluding remarks.** Rosen, L. Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

There appeared to be unanimity on the proposition that energy and environmental problems are following a course which threatens to overwhelm all nations and all peoples unless we take corrective actions and soon. There also was unanimity on the thesis that many of the global problems require international cooperation and collaboration on a scale never before experienced and that this is a matter of survival. Nuclear energy, in its most horrible form, not only brought an end to a terrible war but has also served to discourage war between the major powers for more than 40 years, the longest such period in all of modern history, which dates back about 350 years. Nuclear arsenals, obnoxious though they are, have helped buy time for the world to put its political establishment on a path which makes global war less and less probable. This must continue but, in addition, we now need to buy time (50-100 years) to develop environmentally benign energy sources that are affordable and that will alleviate the instabilities imposed by islands of affluence in a sea of despair. This conference reinforces belief that nuclear energy can help mightily to solve that problem. In fact, it appears to be one of very few realistic options available to us. But we will fail in making this option available if we do find a way to increase the literacy of the world's people, and especially their leaders, about environmental matters generally and about the nuclear-energy option in particular. We must find ways to provide factual information with impeccable honesty and high credibility. I am hopeful that the information generated by this conference, widely disseminated, will help to do that and also to foster such conferences in the future.

2901 Energy Analysis and Modeling

Refer also to citation(s) 19728, 19748, 19763

19682 (IKE–8-18) **User's guide for the model MADE II.** Saboohi, Y.; Emhardt, F. Stuttgart Univ. (Germany, F.R.). Inst. fuer Kernenergetik und Energiesysteme. Oct 1989. 113p. Order Number DE90753471. Available from NTIS (US Sales Only), PC A06/MF A01.

Model MADE-II (Model for Analysis of Demand for Energy) is an energy demand model. This model has been developed on the basis of combined application of statistical, econometric and engineering process techniques. A detailed description of the theoretical concepts of the model and mathematical functions that are

to represent the relationship between energy demand and socio-economic and technical determinants is reported in 'Model for Analysis of Demand for Energy'. The present report is devoted only to describing software of MADE-II and the structure of input data. This report is intended to provide a guidance to the user of the model. Following introduction, the structure of the model MADE-II will be outlined briefly in chapter two. Chapter three is devoted to a description of the structure of the software. Chapter three is then followed by presentation of input data structure. (orig./UA).

19683 (IKE–8-19) **Model for analysis of demand for energy MADE II.** Saboohi, Y. Stuttgart Univ. (Germany, F.R.). Inst. fuer Kernenergetik und Energiesysteme. Oct 1989. 58p. Order Number DE90753445. Available from NTIS (US Sales Only), PC A04/MF A01.

The present report is to provide a description of model MADE-II (Model for Analysis of Demand for Energy). Model MADE-II lends itself to an analysis of useful energy demand and to a simulation of the whole energy system. Being departed from socio-economic development and rising living standard of the population, useful energy demand in different economic sectors, urban and rural households and transport sector is estimated and consumption of different fuels at any level of the energy system is then simulated. Model MADE-II constitutes many options for estimation of required energy and its structure has been made flexible, so that it can be applied in analyzing energy demand in different conditions. In the present report a conceptual description of various options in the model and basic notions behind different approaches are illustrated and the main behavioural and balancing equations are outlined. (orig./UA).

2902 Economics and Sociology

Refer also to citation(s) 19468, 19638, 19644, 19647, 19649, 19650, 19656, 19657, 19672, 19673, 19679, 19680, 19681, 19714, 19732

19684 (LA–11728-C, pp. 123-129) **Agriculture: An area ripe for cooperation.** Ehrlich, A.H. (Stanford Univ., CA (USA)). Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

In 1989, the world food picture is not a pretty one. The 1988 drought afflicted the prime grain-growing regions of North America, China, and the Soviet Union. Problems in food production and as well as environmental concerns for these areas are discussed. 29 refs.

19685 (LA–11728-C, pp. 161-165) **Geothermal energy: An international resource.** Greider, B. Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

The heat of the planet's interior ascends in certain discernible trends around the globe. Above 10,000 foot depths this energy is being recovered as an additional source of energy without the transportation problems and the combustion effects of fossil fuels. In prime areas geothermal energy is used for space heat, industrial processing, and the production of electricity. At all commercial sites the energy produces heat and/or electricity at prices that are less than any new capacity using fossil or nuclear fuels. The critical immediate problem facing the international community is the use of energy located where it is needed, avoiding long transportation paths (needing to be politically and militarily protected), and avoiding the recognized hazards of increased combustion and nuclear wastes. Government energy policy should be faithful to the long-range view that man can create and develop energy systems to use the abundant ubiquitous heat of the Earth that is being constantly generated. The elegant simplicity of developing man-improved geothermal reservoirs that will produce useful heat at prices that will not exceed the true cost of using fossil fuels moved around the globe will stand up to consequential analysis. The economics of fuel supply systems (exploration, development, production, and distribution) are driven by the price and location of oil. World reserves are concentrated in regions having significant potential for supply disruption. Rising dependence on oil imports increases the risk of an economically damaging shortfall. The skilled labor force necessary to produce the amount of oil we presently need is no longer indigenous. Increasing dependence on foreign sources of energy leads to a reduction in the flexibility of planning a foreign policy we can implement. As our energy sources become international, our military obligation increases to protect the sources.

19686 (LA–11728-C, pp. 166-170) **Observation on energy usages in developing countries: Opportunities and problems.** Gross, W.A. (Univ. of New Mexico, Albuquerque (USA)). Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

In proposing global solutions, it is necessary to understand the limitations imposed due to the masses of LDC poor. Imagine for example that an expatriate came to any of us and proposed that we put 3/4 of our savings into some new artifact that the expatriate told us would significantly improve the quality of our life. Furthermore, we and our families have to work nearly continuously to provide the necessities of life and have little marginal time available. When the expatriate proposes a system for using the artifact that would absorb, we guess, 3 hours a day with a promise of saving us 5 hours a day of work sometime in the future, would we agree? Even if the expatriate provided the capital, would we be willing to make the commitment and put in the 3 hours per day? Suppose, further, that the artifact and system are completely alien to our culture and experience, would we listen politely? The Conference has general agreement that the greenhouse and other environmental problems require immediate attention and significant changes to minimize or eliminate the threats of serious degradation of quality of life worldwide. The Conference proposes that developed countries limit or reduce their CO_2 emissions to permit developing countries to produce more CO_2 as they proceed with their own development. Some boundary conditions are given that need to be considered.

19687 (LA–11728-C, pp. 260-265) **The greening of superpower relations: Cooperative ventures in environmental protection and conservation of resources.** McClave, D. (Library of Congress, Washington, DC (USA)). Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

Ronald Reagan's favorite Russian expression doveryay, no proveryay (trust, but verify). Improbably as it all seemed just five years ago, the superpower verification business has been booming. Each day seems to bring with it a new and wondrous event. In June: Chairman of the Joint Chiefs of Staff Admiral Crowe in the cockpit of a BLACKJACK strategic bomber; a team of American scientists measuring the radiation of a cruise-nuclear warhead aboard the Slova, one of the Soviet navy's most powerful ships of the line; in 1988 American inspectors bringing home shrapnel souvenirs of SS-20 missiles exploded deep in Central Asia; General Akhromeyev on a guided tour of the Pentagon and in a B-1B bomber. Consequently, no proposal for building confidence is too farfetched. That assumption underlies the content and the thrust of this paper. In energy and the environment, as in many areas, there is a strong element of parallelism in superpower experience. There is a rising environmental consciousness in the both countries. Strong ecological and geographical incentives exist for cooperation. Specific efforts are also discussed.

19688 (LA–11728-C, pp. 395-401) **Global industrial society - Vision or nightmare?.** Slaus, I. (Ruder Boskovic Institute, Zagreb (Yugoslavia)). Los Alamos National Lab., NM (USA). Nov 1989.

(CONF-8907103--: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

The Club of Rome chose to concentrate its 21st meeting in Hanover on the topic of global industrialization. A number of countries, previously classified as developing, have entered the global industrialization system. Some of them have wisely based their development on widespread education and research development (R & D). Is this global industrialization a vision or a nightmare? Certainly, economic growth in the developing countries is a basic need and is a global concern and responsibility. However, the very assumption of global industrialization raises at least three questions: (1) is the word industrialization appropriate to the reality of the present economic development of most developed countries, based increasingly on information and services? (2) What is the environmental impact of this global industrialization? For the first time man is threatening his own environment. Hitherto environmental problems have been mainly local could be cured by local action. With the appearance of a number of global phenomena, e.g the greenhouse effect, acid rains, thinning and ruptures in the ozone layer, and the worldwide distribution of nondegradable chemicals, environmental issues can no longer be dealt with individual countries. In view of the environmental constraints how can the urgent needs of Third World be met? and, (3) Is the technology-based economic growth of the previously industrialized countries the unique inevitable path to development for all countries and all cultures? These questions were discussed at the Hanover meeting. The author's understanding of these deliberations, and his opinions are given. 16 refs.

19689 (LA--11728-C, pp. 426-432) **Energy security in a competitive world.** Stevenson, M.G. Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103--: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

The world is shrinking and becoming increasingly interconnected. Events in one part of the world quickly impact other parts of the world. Rising standards of living in developed countries, along with rapid communications and growing, mobile populations, go hand in hand with greater worldwide interconnectedness but at the same time are leading to a greater rate of resource depletion. Adequate and economical energy resources are one of the crucial factors in maintaining and increasing standards of living around the world, yet nonrenewable energy resources are being depleted. The international marketplace is also becoming more tightly interconnected and competitive. Increasing trade competition among nations may lead to greater economic efficiency and, on the whole, to improved living standards in successful countries, but competition also contributes to barriers against cooperation. International trade competition may be leading to a tendency for competing nations to become more parochial in technology research and development. The impact of growing populations and rising living standards on the world's environment is also increasing and becoming more pervasive. Solid waste disposal is an increasingly aggravating problem, and hazardous waste and toxic wastes are even more difficult to deal with. Acid rain, global climate change, ozone-layer depletion, stream and harbor pollution, and the resulting pollution of the oceans are all evidence of a highly interconnected world. It is easy to argue that solutions must be political, economic, and social. In large part this must be the case; but as technologists, we want to do all we can to give political, economic, and social forces the best opportunity to succeed. Technology will be part of the solution and not just part of the problem of securing adequate energy supplies with acceptable environmental impact. 2 refs.

2903 Environment, Health, and Safety

Refer also to citation(s) 19272, 19273, 19313, 19335, 19421, 19450, 19585, 19635, 19636, 19639, 19641, 19642, 19645, 19646, 19648, 19649, 19650, 19652, 19654, 19655, 19656, 19657, 19665, 19666, 19667, 19670, 19671, 19672, 19673, 19674, 19675, 19676, 19677, 19678, 19679, 19680, 19681, 19687, 19688, 19689, 19708, 19716, 19720, 19721, 19724, 19725, 19726, 19733, 19784, 19808, 19821, 20273, 20277, 20292, 20366, 20367, 20392, 20399, 20436, 20464, 20491

19690 (HAZ--CE02855, pp. 349-354) **Pipeline emergency response: A cooperative effort.** McLeod, I. (Edmonton Area Pipeline and Utility Operators Committee, Edmonton, AB (Canada)). Haztech Canada, Edmonton, AB (Canada). 1988. (CONF-8810478--: Haztech western Canada: hazardous waste management and environmental control conference, Edmonton (Canada), 5-6 Oct 1988; CE--02855). In *Haztech Western Canada '88: Hazardous waste management and environmental control conference proceedings.* Available from Haztech Canada, 4936-87th St., no. 26, Edmonton, AB, CAN T6E 5W3. Prices: $50.00 CAN.

This paper discusses the Edmonton Area Pipeline and Utility Operators Committee (EAPUOC), its history, its composition, and its action to organize pipeline emergency response through cooperation. This organization was created after a pipeline accident in the area in early 1979. The members are various city of Edmonton departments, 18 pipeline and resource companies, 5 utility operating companies and 7 municipal and regulatory compliance groups. Emergency planning, emergency response exercises and actions to inform the public since the inception of EAPUOC are discussed.

19691 (HAZ--CE02857, pp. 341-344) **Clean-up following the PCB fire at St. Basile-Le-Grand.** Paquin, J. Haztech Canada, Edmonton, AB (Canada). 1989. (CONF-8905280--: Haztech Canada Toronto '89: environmental control/hazardous waste management conference, Mississauga (Canada), 16-18 May 1989; CE--02857). In *Haztech Canada Toronto '89: Environmental control/hazardous waste management conference proceedings.* Available from Haztech Canada, 4936-87th St., no. 26, Edmonton, AB, CAN T6E 5W3. Prices: $50.00 CAN.

This paper is about the fire that took place on August 23, 1988 at Saint-Basile-le-Grand, Quebec, in a polychlorinated biphenyls (PCBs) warehouse, and about the remedial measures adopted for its consequences. It describes the evacuation of the area, the nature of the wastes (drums, capacitors, and transformers), their emptying and safe storage, the analysis of the area for PCBs, dioxin, and furans, and its decontamination (water, metal, and concrete). Demobilization was completed on December 23, 1988.

19692 (LA--11728-C, pp. 105-110) **Environmental collaborations in the use of accelerator mass spectrometry.** Davis, J.C. (Lawrence Livermore National Lab., CA (USA)); Finkel, R.C. Los Alamos National Lab., NM (USA). Nov 1989. DOE Contract W-7405-ENG-48. (CONF-8907103--: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

Accelerator Mass Spectrometry (AMS) is a technique for analyzing extremely low levels of radionuclides. The technique was first demonstrated slightly over a decade ago at three laboratories. The ability to do single atom detection independent of the half-life of the isotope has allowed AMS to extend the applicability of many research areas that use isotopic tracers. At present, there are about 20 accelerator facilities world-wide where such measurements are possible. Only a limited amount of time is available due to other missions. Two dedicated facilities in North America are at the University of Toronto and the University of Arizona. Existing applications of AMS are discussed along with the opportunity for an extended international program to develop AMS as a tool for large scale environmental measurements. 6 refs., 1 fig.

19693 (LA--11728-C, pp. 111-119) **Reducing the devastating effects of cataclysmic events: Cooperation.** Jing Ding (Beijing Institute of Technology (China)); Fong, P. Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103--: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

Natural calamities, including earthquakes, land sinkings, volcanos, floods, tsunamis, hurricanes, avalanches, lightnings, forest fires, are discussed. Their devastating effects can be alleviated by cooperative efforts, sometimes international, among all concerned. The successful earthquake management of the Haicheng event is discussed as an example. Now the authors have environmental calamities, including erosion floods, dam failures, acid rain, ozone depletion, and the global greenhouse effect. There are empirical and theoretical questions about whether the greenhouse effect leads to global warming or polar ice melting. The warming prediction was based on model calculation with an incorrect boundary condition. When corrected with the right boundary condition, the models predict ice melting. The same is borne out in independent static and dynamic theories. Thus, there will be no greenhouse warming, only a sea level rise of up to 200 feet, which is much worse. The only way out is replacing fossil fuels by nuclear power. The nuclear fear is analyzed in terms of the Don Quixote syndrome and Laplace dictum. The lessons of Three Mile Island and Chernobyl actually strengthen the case of nuclear safety. New reactor technology and design will make it even safer. After 250 years of studying the history of the earth, geologists are now able to show that it is nothing but a long series of gradual changes and violent events. What was true in the past will remain so in the future, and cataclysms will occur again and again. Earthquakes, land subsidence and volcanic eruptions; flood and drought; the tsunami, tropical cyclones and avalanches; lightning and forest fires; have occurred ever since mountains, oceans, rivers, atmosphere, and ice sheets have been on the earth, and they will continue to happen.

19694 (LA–11728-C, pp. 130-142) **World-wide solar-power satellite system (WWSPSS) to reduce CO_2: Do you have a better way?.** Eisenstadt, M.; Sorenson, J. Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

In the late sixties, a method was proposed for generating electric power in space for use on earth. Large arrays of photovoltaic cells would be placed in geosynchronous orbit about the earth, and the power generated would be sent to earth by microwave transmitters and receivers put into distribution grids. New political and environmental situations now make this proposal highly attractive. The technical, financial and environmental aspects are discussed along with the international aspects. 18 refs.

19695 (LA–11728-C, pp. 194-200) **Solar energy and the global commons.** Hubbard, H.M. (Solar Energy Research Institute, Golden, CO (USA)). Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

In today's world we find ourselves grappling with issues whose resolution will not be possible without international dialogue and cooperation. The pressure of increasing world population, the threat of nuclear conflict, and impending global climate change respect no national boundaries. Along with the management of the oceans and space, these issues demand unprecedented levels of cooperation, trust, and confidence among the world's community of nations. Energy is the thread that runs through most of the global issues we face today. Modern energy technologies make the world run. They are as vital to developments in communications and weaponry as they are to economic and political stability. They make possible the tools we need to manage and develop our planetary resources. Conventional energy technologies are also extracting an increasingly high price from our natural environment. Air pollution, acid rain, and the depletion of the ozone layer are all linked to our use of energy. Climate change is expected due to the accumulation of greenhouse gases in the atmosphere and poses an awesome challenge to humanity over the course of the next 100 years. Such serious environmental problems mean solar and other unconventional energy technologies must play key roles in our global energy future. Deployed as part of international strategies to slow global warming, they will deliver energy to industrial societies and developing nations alike. Still, it's naive to assume that technology alone can solve today's complex environmental, economic' and social problems. Deforestation, the threat of nuclear conflict, economic equity, and global warming all have technological dimensions. Most of the time, it's easier to deal with the technological side of things than the social and political realities that accompany them. 8 refs.

19696 (LA–11728-C, pp. 201-204) **Summary address: Science, technology, and world affairs.** Kapitza, S.P. (Institute for Physical Problems, Moscow (USSR)). Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

The world is passing through transition. With good authority it has been said that the Cold War is over. Now that a war is over, you have the victors and the vanquished. You know who won—Japan and West Germany. I suppose you can guess who lost. That is why we are now disarming ourselves. Losing this strange war is just as strange as fighting it. The war was never fought outright. The great instruments of destruction first born in New Mexico were never used, the rockets never took to their deadly course. At great expense we deterring each other, finally escalating the arms race to such a level of armaments that a mere fraction what is now available would bring us beyond any imaginable limit of destruction. If the balance of power were spilt by the numbers of units, it is well known that the wars were and are fought by soldiers. There the practical military experience of our countries is revealing, for the last two real wars have been lost, lost in the old way of humiliation and retreat from countries that are no suffering from deadly scars of a modern armed conflict. Without even using nuclear weaponry, or other very sophisticated arms, what was left was not much different from the aftermath of a total war of attrition and destruction without resolving any of the social or political issues that were the proffered reason for war. Hopefully, these experiences provide sufficient evidence to prove the futility of modern militia might, and that is really why WW III was lost unfought. In the USSR, perhaps more than others, we see the consequences of defeat: economy in disarray, inflation, drastic necessity for basic changes, and a loss of ideas, ideals and ideology for that matter. Hence perestroika. But the imperatives for perestroika are not confined to the USSR.

19697 (NEI-NO–101, pp. 19) **Legislative controls for use of oil based fluids offshore Norway.** Solhjell, S. (The State Pollution Control Authority, Oslo (Norway)). Norsk Petroleumsforening, Oslo (Norway). 1983. (CONF-8310456–: 1. Northern European drilling conference, Kristiansand (Norway), 24-26 Oct 1983). In *First Northern European drilling conference, Kristiansand, Norway, October 24-26, 1983.* Order Number DE90748476. Available from NTIS (US Sales Only), PC A21/MF A01.

The paper deals with the legislative controls for the offshore use of oil-based fluids in Norway. The legislative measures are considered, and also a short conclusion on the probable future regulations in this field is given. 1 tab.

19698 (NEI-NO–101, pp. 35) **Effects of cutting discharge from offshore operation: An overview. .** Indreboe, G. Norsk Petroleumsforening, Oslo (Norway). 1983. (CONF-8310456–: 1. Northern European drilling conference, Kristiansand (Norway), 24-26 Oct 1983). In *First Northern European drilling conference, Kristiansand, Norway, October 24-26, 1983.* Order Number DE90748476. Available from NTIS (US Sales Only), PC A21/MF A01.

The paper gives a survey on the effects of cutting discharge from offshore drilling by using water-based or oil-based muds in operation. The increased application of oil based mud and discharge of cutting with significant amounts of oil adhering to it has generated attention and concern for the environmental impact it may cause. Extensive field investigations are being carried out to establish the extent of impact, and some conclusions seem already to appear. 31 refs.

19699 (PB–90-122128/XAB) **Toxic chemical release inventory risk screening guide (Version 1.0). Volume 1. The process. Volume 2. Appendices. Final report.** Klauder, D.; Saunders, L. Eastern Research Group, Inc., Arlington, MA (USA). Jul 1989. 355p. Available from NTIS, PC A16/MF A02.

The guide describes some of the challenges raised by the Toxic Release Inventory (TRI) data and to suggest ways of approaching them. The guide suggests steps that can be taken to answer two key issues of concern: setting risk-based priorities for followup investigation of the TRI facilities and chemicals within geographic area of interest, and identifying data needs and approaches for collecting information necessary to respond to health and ecological questions from the public. The guide is directed at those individuals who are involved in interpreting and explaining environmental pollution, exposures, and health risks to the general public, especially at the local or sub-State level. Many users of the guide will already be well versed in evaluating risk and/or in helping members of the public understand and deal with toxic chemicals, but Title 111 - particularly, the Section 313 release data - presents new challenges for everyone.

2904 Energy Resources

Refer also to citation(s) 19657, 19671, 19674, 19680, 19796

19700 (DOE/ID/10368–1-Vol.2) **A study of industrial waste stream sources for wet oxidation: Volume 2.** Versar, Inc., Springfield, VA (USA). 20 Dec 1989. 327p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AP07-89ID10368. Order Number DE90007196. Available from NTIS, PC A15/MF A01 - OSTI.

This document contains compiled data from studies on wastewater processing to recover energy sources. The text for these studies is contained in volume I of the same title. (FSD)

19701 (ESC-WR–89-21) **Historical energy data: Quantities, values and prices.** Koenders, N.J. Stichting Energieonderzoek Centrum Nederland, Petten (Netherlands). Energie Studie Centrum. Dec 1989. 68p. (In Dutch). Available from Netherlands Energy Research Foundation ECN, P.O. Box 1, 1755 ZG Petten, Netherlands.

The Energy Study Centre of the Netherlands Energy Research Foundation collects data on several energy related subjects. An overview is given of a number of available time series on input and output and prices of natural gas, electricity, coal and derivatives, crude oil and oil products, uranium and the materials aluminium, iron and steel, zinc, oxygen and sulfuric acid. The time series vary between 1960 and 1990. Also a balance of payments is given from which the development of the balance of goods can be deduced as well as the influence of the energy sources on the balance of goods. Finally data are presented on the exchange of the dollar, inflation, interest and national income.

19702 (PB–90-133364/XAB) **Programs for management of water withdrawls in Illinois.** Eheart, J.W.; Rahman, M.R.; Barclay, J.P.; Saleth, R.M.; Braden, J.B. Illinois Univ., Urbana, IL (USA). Dept. of Civil Engineering. Aug 1989. 163p. Available from NTIS, PC A08/MF A01.

In Illinois there are few strong regulatory programs to restrict water use. In parts of the state streamflows and groundwater tables have recently become threatened. In this report, alternative possible permit programs for water withdrawal management in Illinois are discussed and compared qualitatively in the context of six management objectives: ease of administration and enforcement; equity; maintenance of water resources; robustness; economic efficiency; and political feasibility. The report also focuses on three quantitative questions; What economic gains are to be expected from permit transfers, using corn irrigation as a case study; how stringent restrictions must be to prevent third-party impairment from groundwater transfers; and how important are the problems of market thinness and strategic bidding to a full competitive system.

2905 Research, Development, Demonstration, and Commercialization

Refer also to citation(s) 19468, 19478, 19518, 19519, 19523, 19528, 19820, 20133, 20139, 21011

19703 (DOE/EIA–0035(89/11)) **Monthly energy review, November, 1989.** USDOE Energy Information Administration, Washington, DC (USA). Office of Energy Markets and End Use. 23 Feb 1990. 137p. Sponsored by U.S. DOE Management & Administration. Order Number DE90007201. Available from NTIS, PC A07/MF A01 - GPO - OSTI; GPO Dep.

The subject report, published in October 1989 by the Energy Information Administration, is one of a series of three reports on how US households use energy. It is based on data collected in the 1987 Residential Energy Consumption Survey (RECS). The survey includes single-family homes, apartments, and mobile homes, and covers the six major sources of energy consumed in the residential sector: electricity, natural gas, fuel oil, kerosene, liquefied petroleum gases (LPG), and wood. Data are presented in the form of aggregate totals and household averages. This "Highlights" reviews some of the major findings of the report. The primary uses of energy in US households include space heating and cooling, heating water, refrigerating foods, cooking foods, and operating household appliances. In 1987, energy consumption of the major sources of residential energy (excluding wood) totaled 9.1 quadrillion Btu. (Consumption of wood was an estimated 0.85 quadrillion Btu of energy.) From 1978 to 1987, total energy consumption decreased 14 percent while the number of households increased 18 percent (Table FE1). The lower level of consumption in 1987 was due partly to a warmer winter in that year than in 1978 and partly to conservation efforts.

19704 (DOE/ER–0438) **Programs of the Office of Energy Research.** USDOE Office of Energy Research, Washington, DC (USA). Jan 1990. 29p. Sponsored by U.S. DOE Energy Research. Order Number DE90006437. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Office of Energy Research sponsors long-term research in certain fundamental areas and in technical areas associated with energy resources, production, use, and resulting health and environmental effects. This document describes these activities, including recent accomplishments, types of facilities, and gives some impacts on energy, science, and scientific manpower development. The document is intended to respond to the many requests from diverse communities — such as government, education, and public and private research — for a summary of the types of research sponsored by the Department of Energy's Office of Energy Research. This is important since the Office relies to a considerable extent on unsolicited proposals from capable university and industrial groups, self-motivated interested individuals, and organizations that may wish to use the Department's extensive facilities and resources. By describing our activities and facilities, we hope not only to inform, but to also encourage interest and participation.

19705 (DOE/MA–0404) **Annual report to Congress on competition in contracting: FY 1989.** USDOE Assistant Secretary for Management and Administration, Washington, DC (USA). Procurement and Assistance Management. [1990]. 25p. Sponsored by U.S. DOE Management & Administration. Order Number DE90007846. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Department of Energy (DOE) is pleased to submit its fifth annual report to the Congress as required by Public Law 98-369, the Competition in Contracting Act of 1984. The Department's fiscal year (FY) 1989 activities and accomplishments to increase competition in acquisition contracts are covered in this report along with the goals and plans for FY 1990.

19706 (ORNL–6541/V2/P1) **Energy Technology R and D: What could make a difference?: Volume 2: Part 1, End-use technology.** Miller, J.T. (ed.); Fulkerson, W.; Reister, D.B. Oak Ridge National Lab., TN (USA). Dec 1989. 172p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90006434. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

Early in 1988, the management of Oak Ridge National Laboratory (ORNL) decided to organize an internal study to review the status of energy technologies and to identify the research and development opportunities that could make a difference for both the United States and the rest of the world. More than 100 ORNL staff members were organized into teams to review the status of technology in 18 areas covering energy use, energy supply, and crosscutting science. Each team attempted to identify significant technological advances that could be made within a reasonable time and cost. The results of the study are being published in two volumes. The first volume is the synthesis report, while the second volume is the collection of the 18 team reports. The three parts of Volume 2 review (1) end-use technology, (2) supply technology, and (3) crosscutting science and technology. This part of Volume 2 reviews end-use and energy conversion technologies. Also included in this part are reports on storage and on the energy carriers, electricity and hydrogen.

19707 (ORNL–6541/V2/P2) **Energy Technology R and D: What could make a difference?: Volume 2: Part 2, Supply technology.** Miller, J.T. (ed.); Fulkerson, W.; Reister, D.B. Oak Ridge National Lab., TN (USA). Dec 1989. 162p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90006435. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

Early in 1988, the management of Oak Ridge National Laboratory (ORNL) decided to organize an internal study to review the status of energy technologies and to identify the research and development opportunities that could make a difference for both the United States and the rest of the world. More than 100 ORNL staff members were organized into teams to review the status of technology in 18 areas covering energy use, energy supply, and crosscutting science. Each team attempted to identify significant technological advances that could be made within a reasonable time and cost. The results of the study are being published in two volumes. The first volume is the synthesis report, while the second volume is the collection of the 18 team reports. The three parts of Volume 2 review (1) end-use technology, (2) supply technology, and (3) crosscutting science and technology. This part of Volume 2 reviews supply technology.

2906 Nuclear Energy

Refer also to citation(s) 19478, 19556, 19557, 19567, 19585, 19631, 19632, 19633, 19634, 19636, 19639, 19640, 19642, 19643, 19656, 19658, 19659, 19660, 19661, 19664, 19666, 19668, 19669, 19670, 19675, 19678, 19679, 19680, 19681, 19687, 19689, 19692, 19693, 19703, 19716, 19725, 21011

19708 (LA–11728-C, pp. 102-104) **A cleaner environment with nuclear heating.** Cuttler, J.M.; Hilborn, J.W. Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

In Canada, Scandinavia and Central Europe, about 30 percent of the primary energy consumed is used for heating buildings. District heating systems provide greater fuel economy, better pollution control and more flexibility to use a variety of fuels, including municipal waste and bio-mass. Atomic Energy of Canada has initiated a program to develop and apply nuclear technology specifically for district heating. Some characteristics of the new reactor for this purpose are presented. 1 ref., 1 fig.

19709 (LA–11728-C, pp. 234-240) **Opportunities for international cooperation in nuclear accident preparedness and management: Procedural and organizational measures.** Lathrop, J. (Strategic Insights, Los Altos, CA (USA)). Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

In this paper we address a difficult problem: How can we create and maintain preparedness for nuclear accidents? Our research has shown that this can be broken down into two questions: (1) How can we maintain the resources and expertise necessary to manage an accident once it occurs? and (2) How can we develop plans that will help in actually managing an accident once it occurs? It is apparently beyond the means of ordinary human organizations to maintain the capability to respond to a rare event. (A rare event is defined as something like an accident that only happens once every five years or so, somewhere in the world.) Other more immediate pressures tend to capture the resources that should, in a cost/benefit sense, be devoted to maintaining the capability. This paper demonstrates that some of the important factors behind that phenomenon can be mitigated by an international body that promotes and enforces preparedness. Therefore this problem provides a unique opportunity for international cooperation: an international organization promoting and enforcing preparedness could help save us from our own organizational failings. Developing useful accident management plans can be viewed as a human performance problem. It can be restated: how can we support and off-load the accident managers so that their tasks are more feasible? This question reveals the decision analytic perspective of this paper. That is, we look at the problem managing a nuclear accident by focusing on the decision makers, the accident managers: how do we create a decision frame for the accident managers to best help them manage? The decision frame is outlined and discussed. 9 refs.

19710 (PPA-AL–10) **Sustaining the nuclear power option in Malaysia: Continuing assessment and the role of the research reactor.** Jamal Khaer bin Ibrahim. Unit Tenaga Nuklear, Bangi, Selangor (Malaysia). 1989. 17p. (CONF-8905281–: 3. Workshop on nuclear electric power future in the Asia Pacific region, Jakarta (Indonesia), 26 May 1989). Order Number DE90617948. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

This paper describes the approach taken to establish the information base required prior to a decision on a nuclear power programme, and the strategy adopted and the rationale behind the development of the basic core expertise on nuclear reactor technology. The effect of a lack of decision on the question of nuclear power generation on efforts to build this core technical expertise is also described. (author).

2907 Transport and Storage

Refer also to citation(s) 19633

2908 Heat Utilization

Refer also to citation(s) 19685, 19708

19711 (NEDOJ-P–8818) **Feasibility study on introduction of new energy system for resort development plan (2).** New Energy Development Organization, Tokyo (Japan). Mar 1989. 111p. (In Japanese). Order Number DE90753152. Available from NTIS (US Sales Only), PC A06/MF A01.

Distributed energy system was studied as the energy system for recreation areas. The distributed energy system is composed of cogeneration system, solar energy utilizing system, fuel cell system, etc. The conceptual design were conducted to the two areas in the recreation development plan in Shikoku, and such cegeneration system was selected, as combined system of solar energy utilizing system (solar battery) to the above one, and as fuel cell system to the other. The basic conditions adopted in these system were that each of them is able to simultaneously supply electric power and heat energy. Cogeneration system is considered to be superior to others in efficiency, economy, technical matuality, etc. Solar energy utilizing system and fuel cell system are pollution abatement energy system, and they are considered to be important for future of Japan. 44 figs., 34 tabs.

2910 Conservation

Refer also to citation(s) 19667, 19671, 19687, 19706, 19707, 19724, 19731, 19817, 19820

19712 (DOE/CE–0210) **Annual operating plan, transportation energy conservation, fiscal year 1990.** USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (USA). Office of Transportation Systems. Jan 1990. 89p. Sponsored by U.S. DOE Conservation & Renewable Energy. Order Number DE90006365. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The Office of Transportation Systems (OTS) is responsible for working with the private sector to improve the energy-use efficiency of the transportation sector and assist in the reduction of the sector's dependence on petroleum. The transportation sector currently uses over a quarter of all energy in the US and over 63 percent of all petroleum. In fact, the transportation sector currently uses 31 percent more oil than the US crude oil production level. The goal of the Office is to improve the efficiency with which the sector uses petroleum and to enhance the flexibility of fuel use options in transportation-related technologies. This goal is underscored by the fact that such technologies have potentially significant leverage on the US and world oil situation. Reductions in US transportation oil use can enhance energy security, reduce oil imports and related trade payments to foreign countries, and enhance economic growth. 4 tabs.

19713 (EMR/CANMET–81-25(TR), pp. 46-52) **Energy conservation: The viable alternative.** Chic, W. (Ontario Ministry of Energy, ON (Canada)). Canada Centre for Mineral and Energy Technology, Ottawa, ON (Canada). Apr 1981. (CONF-8010391–: Energy conservation in the foundry industry, Cambridge (Canada), 30-31 Oct 1980; MICROLOG–89-05075). In *Energy conservation in the foundry industry*. Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $0.34 CAN per page, $3.40 minimum; MF $10 CAN.

This paper discusses the Ontario government's role in energy conservation. The need for energy conservation and the methods through which energy efficiency can and has been achieved were reviewed. Energy conservation initiates undertaken by the Ontario government were summarized. In 1976 a five-year plan was established aimed at reducing energy consumption in government buildings by 15%. This goal was achieved in two years resulting in a savings of $20 million. A joint provincial-municipal steering committee was established in 1978 to offer advice and expertise to municipalities on energy conservation in areas such as building management, transportation, urban lighting, and waste disposal. An energy audit program has been established for municipalities and as planned for industry.

2920 Supply, Demand, and Forecasting

19714 (DOE/EIA–0527(90)) **Assumptions for the Annual Energy Outlook 1990.** USDOE Energy Information Administration, Washington, DC (USA). Office of Energy Markets and End Use. 13 Feb 1990. 110p. Sponsored by U.S. DOE Energy Information Administration. Order Number DE90007086. Available from NTIS, PC A06/MF A01 - GPO - OSTI; GPO Dep.

This Assumptions report is an auxiliary document to the Annual Energy Outlook 1990 (AEO) DOE/EIA-0383(90). It presents a more detailed discussion of the assumptions underlying the forecasts in the AEO. The forecasts presented in the AEO are outputs of the PC-AEO Forecasting Model (PC-AEO), a personal computer-based modeling system using a popular spreadsheet software. The PC-AEO is an economic equilibrium modeling system, with component modules representing electric utility pricing and fuel consumption, coal supply and end-use pricing, petroleum product pricing, crude oil production, and natural gas production and pricing. Also included are energy demand models representing end-use energy consumption by major end-use sector. The PC-AEO accounts for the interactions among these components of energy markets and projects prices and quantities for which energy supply equals demand. In the AEO, five forecast cases are presented: a base case, low and high world oil price growth, and low and high macroeconomic growth. The base case is the central forecast. The four other cases are presented to reflect the uncertainty inherent in any forecast of the future. They are based on reasonable lower and upper bounds on two key factors that affect energy trends – world oil price and the rate of economic growth, and characterize a reasonable range of uncertainty for domestic oil production and petroleum imports under current energy policy. This Assumptions report presents the oil price and economic growth assumptions, as well as other quantitative assumptions for specific demand and supply modules of PC-AEO, that were used by EIA in developing the AEO base case and alternative scenario projections. Further details on the methodology, data, and assumptions are available from the contacts listed in the Preface. 18 figs., 3 tabs.

19715 **Energy efficiency - the perils of a plateau.** Schipper, Lee (Lawrence Berkeley Lab., CA (USA)); Ketoff, Andrea. *Energy Policy (UK)*, 17(6): 538-542 (Dec 1989).

More efficient energy use brought OECD countries significant oil and energy savings between 1972 and 1985. We estimated that the savings amounted to 16 million bb/day oil equivalent of end-use energy in homes, services, transportation, and manufacturing. However, part of the savings of energy are reversing. And technological improvement in new energy using systems, like cars or appliances, has almost halted. Because energy use is associated with the release of so-called greenhouse gases, this plateau in energy efficiency could aggravate the delicate energy-climate link about which we know so little. (author).

2930 Policy, Legislation, and Regulation

Refer also to citation(s) 19572, 19631, 19644, 19647, 19651, 19652, 19658, 19661, 19662, 19664, 19668, 19669, 19673, 19684, 19689, 19695, 19696, 19725, 19730, 20366, 20464, 21011

19716 (DOE-tr–88-46) **Italian energy policy.** USDOE, Washington, DC (USA). 1988. 281p. Translation of "Lo Schema del Piano," July 7, 1988, 281 p. Sponsored by U.S. DOE Management & Administration. Order Number DE90002740. Available from NTIS, PC A13/MF A01; OSTI; INIS; GPO Dep.

This document discusses problems associated with Italian energy policy; economic and industrial development as it relates to that policy is covered. Specific areas covered are: (1) the basis of Italy's new energy policy; (2) energy demand; (3) five objectives; (4) the electrical power system; (5) proposed action; and (6) energy resources.

19717 (HAZ–CE02857, pp. 304-310) **Transport of dangerous goods: Shipping PCB mixture, equipment or articles.** Levesque, A. Haztech Canada, Edmonton, AB (Canada). 1989. (CONF-8905280–: Haztech Canada Toronto '89: environmental control/hazardous waste management conference, Mississauga (Canada), 16-18 May 1989; CE–02857). In *Haztech Canada Toronto '89: Environmental control/hazardous waste management conference proceedings*. Available from Haztech Canada, 4936-87th St., no. 26, Edmonton, AB, CAN T6E 5W3. Prices: $50.00 CAN.

The purpose of this document is to provide the reader with a simple interpretation of the requirements of the Canadian Transport of Dangerous Goods Regulations pertaining to the transport of polychlorinated biphenyls (PCBs) in PCB mixtures and equipment. PCBs are quasi inert, non flammable, low volatility chemical products of the general formula: $C_{12}H_{10-x}Cl_x$. They are environmental contaminants and will concentrate in the food chain hence the Transport of Dangerous Goods Regulations emphasis on containment to prevent release into the environment.

19718 (IEE-SR–212) **Research of trend of energy policy in USA.** Institute of Energy Economics, Tokyo (Japan). 25 Aug 1989. 144p. (In Japanese). Order Number DE90753072. Available from NTIS (US Sales Only), PC A07/MF A01.

The reserch was conducted to study and analize the trend of energy policy by Busch political power or new congress in USA and the policy as against USSR or East Europe sphere, in particular the trend of approach to USSR in energy field. As far as the realization of energy bill is concerned, Busch political power in the first

year seems to be very promising. As President Busch is opposite to gasoline tax, however there is a good possibility of success in the congrss, while in the energy bills the surcharge bill for petroleum is only decided to be rejected. The new political power assume that the endeavor to reformation of USSR is fundamental and systematic one, and they hope that it will bring democratization of life in USSR. Busch political power request the sign of real reformation, and have a intension to promote it. USA hope that USSR government will promote Perestroika into mental reformation, and hope to find it out not in their speech but in their activities in USSR or in various places in the world.

19719 (IE-MOEI–88/0100, pp. 27) **The IEA's country review process: an analysis.** Toner, G. (Carleton Univ., Political Science Dept., Ottawa, (Canada)). Ministry of Energy and Infrastructure, Jerusalem (Israel). Jun 1988. (CONF-880609–: Energy 88: 2. International congress and exhibition on energy, Tiberias (Israel), 5-10 Jun 1988). In *Energy 88. The 2nd international congress and exhibition on energy. Abstracts.* Available from COSTI P.O.B 20125, TEL-AVIV 61201.

Abstract only.

The International Energy Agency's (IEA) country review process is part of its Program for Long Term Cooperation, which includes a series of 12 Energy Principles which act as guidelines for members to follow in developing national energy policies. This program encourages members to develop national energy policies to improve their individual and collective energy security, and calls for strengthened emphasis on energy R&D, including international collaborative projects, coordinated by the IEA. The program is analyzed in the light of the IEA's annual country review process, which involves visits by energy officials from member countries, to assess progress in other member countries. This paper is based on primary research at the IEA secretariat in Paris and on a series of interviews with member country officials who have been involved with the Long Term Office and the country review process. (RP)

19720 (LA–11728-C, pp. 171-178) **Politics of international environmental cooperation.** Haas, P.M. (Univ. of Massachusetts, Amherst (USA)). Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

Transboundary pollution problems require international cooperation for their solution. Yet, countries are commonly averse to cooperate seriously due to doubts about reciprocity, verification, and the common political antipathies that impede interstate cooperation. How then is cooperation to occur? Recently, in the environmental sphere it appears that there has been an emergent new form and process of cooperation, driven not by state power but by the collective beliefs of groups of technical specialists. This presentation will sketch out the dimensions of this incipient mode of environmental cooperation and indicate its boundaries and preconditions, based upon international efforts to protect the Mediterranean Sea and the stratospheric ozone layers from pollution. A checklist is given. There has been a striking amount of successful environmental cooperation in the past decade–in terms of statements or commitments (the signing of international treaties), and in terms of actual deeds (policy making and investments), as well as in terms of actual outputs (environmental quality). The United Nations Environment Programme (UNEP) indicates that of a total of 112 multilateral environmental treaties that had been concluded by 1983, over two-thirds were signed from 1970 to 1983. Moreover, public statements by high-ranking government officials demonstrate a growing environmental consciousness, as has the spread of national expenditures and legislation in support of such efforts. 15 refs.

19721 (LA–11728-C, pp. 179) **Proposal to establish a UN Environmental Security Council and General Assembly.** Haas, P.M. (Univ of Massachusetts, Amherst (USA)); Lipschutz, R.D.; Slaus, I. Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

Because no nation-state is in control of its environmental fate, the following international institutional innovations are proposed to better manage the transnational dimensions of the new global environmental agenda. A proposed creation of a new United Nations environmental body as an adjunct of the existing Security Council. The new body would be bicameral, consisting of: (1) A nation-state chamber that would have representatives from the five permanent members of the Security Council, plus Japan, the European Economic Community (after 1992), and other members on a rotating basis; and (2) A transnational chamber, consisting of representatives from nongovernmental organizations, including corporations, scientific unions, environmental associations, and other related bodies. These two bodies would operate in parallel to the existing Security Council and General Assembly but would be concerned with international environmental questions. Both chambers would be supported by the UN Secretariat and represented in the Secretariat by a newly created Undersecretary General for Environment and Development. The UN Environmental Programme (UNEP) would remain responsible for environmental research and for coordinating the environmental activities of other UN agencies, with a larger budget that would allow it to fully pursue this mission.

2940 Fossil Fuels

Refer also to citation(s) 19159, 19173, 19251, 19255, 19278, 19279, 19282, 19662, 19678, 20354

19722 (HAZ–CE02855, pp. 68-86) **Full service waste management in the oil industry.** Byram, K.J. Haztech Canada, Edmonton, AB (Canada). 1988. (CONF-8810478–: Haztech western Canada: hazardous waste management and environmental control conference, Edmonton (Canada), 5-6 Oct 1988; CE–02855). In *Haztech Western Canada '88: Hazardous waste management and environmental control conference proceedings.* Available from Haztech Canada, 4936-87th St., no. 26, Edmonton, AB, CAN T6E 5W3. Prices: $50.00 CAN.

In late 1987, new provincial regulations were established regarding hazardous wastes, resulting in a considerable impact on the oil industry. The areas of generation, handling and disposal of waste streams have thus become critical to oil field operation, therefore leading to the concept of total waste management. The Energy Resources Conservation Board, Alberta Environment and the Alberta Special Waste Management System, working with a variety of other agencies, have initiated changes in the way waste streams are to be handled. This paper discusses how these changes affect the upstream side of the oil industry. The new guidelines have been set out resulting from health and environment problems, technological advances, amd government regulations. Oil production companies are being affected, with impacts on service companies, on the manufacturing of petroleum products, and on chemical companies. There are 3 types of wastes: regular, special, hazardous. The paper discusses the immediate effects of the new guidelines, their long term effects, the question of who is to handle the management of wastes, what methods are to be used, and the liability considerations. A list of 14 questions as a checklist is included.

19723 (HAZ–CE02855, pp. 147-161) **Special waste issues in the oil and gas industry.** Gillespie, R. (Petro-Canada (Canada)); Bradshaw, M.; Alexander, R. Haztech Canada, Edmonton, AB (Canada). 1988. (CONF-8810478–: Haztech western Canada: hazardous waste management and environmental control conference, Edmonton (Canada), 5-6 Oct 1988; CE–02855). In *Haztech Western Canada '88: Hazardous waste management and environmental control conference proceedings.* Available from Haztech Canada, 4936-87th St., no. 26, Edmonton, AB, CAN T6E 5W3. Prices: $50.00 CAN.

The oil and gas industry has made a number of studies in the past five years toward the implementation of comprehensive special waste management programs. Petro-Canada Resources assmbled, in 1987, a waste management manual to be used by field personnel as an operations handbook. It provides information on waste handling techniques, waste tracking procedures, waste storage, and regulations. Some of the major waste disposal issues

common to the Resources area are filter disposal, landfill use, and oily sludge/sludge disposal. A report issued by the Petroleum Association for Conservation of the Canadian Environment advocates an in-plant procedure for the control of refinery/upgrader waste materials. The model procedure states that some of the duties that must be carried out would be to keep a record of all wastes leaving the plant property, attempt to sell or recycle refinery waste to another industry, direct the disposal of all waste materials to a government approved site, ensure that all hazardous waste are stored in accordance with good practice and government regulations, and maintain an inventory of past disposal methods, sites, and materials. The difficulties that may be encountered are detailed. As a result of preparation for this paper, a number of common requirements arose: internal company education, internal company communication, procedures and guidelines, standards for operation, and public information. 5 refs.

19724 (LA–11728-C, pp. 54-64) **Decline in energy use in the seventies and early eighties.** Borg, I.Y. (Lawrence Livermore National Lab., CA (USA)). Los Alamos National Lab., NM (USA). Nov 1989. DOE Contract W-7405-ENG-48. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

The key to the decline in US energy consumption in the seventies and eighties lies in the US industrial sector. Changes in its output, both in quantity and product mix led to large decreases in energy use, which have persisted to the end of the present decade. Energy saving through improvements in efficiency in the industrial sector, over and above those associated with normal capital stock turnover, appear to be much smaller than those associated with change in the output of the sector. Some of these changes were evident before the rise in the price of fuels in the seventies, but most were set in motion by the price increases. Energy-intensive industries have continued to decline, and import reliance on their products has increased. This is tantamount to importing energy, in the form of products, with no expression in tallies of annual US energy use. By contrast, conservation in other end-use sectors has shown a strong price elasticity. 12 refs., 8 figs.

19725 (LA–11728-C, pp. 184-193) **Insufficiencies in solving global environmental problems by specialized scientific expertise.** Hartwig, S.G. (Universitaet Wuppertal (West Germany)); Kra, R.S. Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

The most paradoxical and urgent problem faces the world today. We find ourselves between the horns of a dilemma. One horn represents the accelerating demand for energy, and the other, the irreversible degradation of our natural environment. There are two directions that we can take to solve our growing global crisis. The first step is to encourage scientific specialists to think in broader terms. The second necessary approach is to make decision makers aware of the complexity of the situation as well as the dangers of tunnel vision that experts often fall into. Therefore, to find a long-term holistic solution, decision makers, be they government officials or academics, must be, themselves, solution oriented and capable of directing scientists along broadened problem-solving pathways. Up till now, scientists have been required to research environmental problems, discover causal associations and determine effects. Contemporary scientists, in the truest sense of the meaning, are no longer generalists but are specialists in their own fields with great depth and accuracy of knowledge. However, experts of high standing may have difficulty visualizing adjacent sciences, which causes them to lose sight of topics peripheral to their main field of interest. The consequence of this can be that solutions to a problem will be sought only within particular and specialized areas, but it is, unfortunately, a fact of life that environmental problems do not come neatly packaged in scientific disciplines: they happen in their entirety, with all their synergistic implications. 5 refs., 5 figs.

2960 Electric Power

Refer also to citation(s) 19623, 19661, 19664, 19703, 19714

19726 (CANWEC–CE02831, pp. 22) **Towards the 21st century: Electricity and the environment: Report 2.2.11. .** Hidy, G.M. (Electric Power Research Inst. (USA)). Canadian National Committee, World Energy Conference, Ottawa, ON (Canada). 1989. (CONF-890901–: 14. world energy conference, Montreal (Canada), 17-22 Sep 1989; CE–02831). In *Energy for tomorrow. Division 2: Energy and the environment: Session 2.2: Environmental assessments: air, water, land.* Available from Canadian National Committee World Energy Conference, Suite 305, 130 Albert Street, Ottawa, ON, CAN K1P 5G4. Prices: $125.00 CAN.

Plentiful supplies of electrical energy have provided a base for worldwide growth in economic development. With electricity production, delivery, and use has come an increasing awareness and concern for the industry byproducts and their possible environmental effects. In the 21st century, this concern will become worldwide. As a result, the electrical utilities will come increasingly under scrutiny for environmental regulation superimposed on economic regulation. In this setting, three major issues arise that may have an effect on utility operations and the cost of electricity. These are acid rain and its effects, change in global climate, and the influence of electric and magnetic fields on humans. These issues are distinctive, but each has motivated a worldwide appraisal for possible mitigative action. The potential of these issues to guide international commitments to environmental protection is examined here, and plans for research to cope with these environmental issues are discussed. A risk assessment and management framework is an appropriate scheme to place these in perspective with a variety of issues expected to confront the electric utility industry for years to come. 23 refs.

19727 (DOE/EIA–0226(89/11)) **Electric Power Monthly, November 1989.** USDOE Energy Information Administration, Washington, DC (USA). Office of Coal, Nuclear, Electric and Alternate Fuels. 12 Feb 1990. 166p. Sponsored by U.S. DOE Management & Administration. Order Number DE90007357. Available from NTIS, PC A08/MF A01 - GPO - OSTI; GPO Dep.

The Electric Power Monthly (EPM) is prepared by the Electric Power Division; Office of Coal, Nuclear, Electric and Alternate Fuels; Energy Information Administration (EIA); Department of Energy. The purpose of this publication is to provide energy decisionmakers with accurate and timely information. The EPM presents monthly summaries of electric utility statistics at the national, Census division, and state level for net generation, fuel consumption, fuel stocks, quantity and quality of fuel, cost of fuel, electricity sales, and retail prices of electricity. Data on net generation are also displayed at the North American Electric Reliability Council (NERC) region level. Additionally, company and plant level information are published in the EPM on capability of new plants, net generation, fuel consumption, fuel stocks, quantity and quality of fuel, and cost of fuel.

19728 (EPRI-EL–6634) **Control center survey: Installed and planned applications software: Final report.** Electric Power Research Inst., Palo Alto, CA (USA); Clauder Systems Research, Inc., San Jose, CA (USA). c Feb 1990. 56p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This project surveyed the utility industry use of applications. In addition, the survey collected information regarding future plans to add applications, interest in and knowledge about new control center technologies and identification of current problems that might be solved by new software applications. Over three hundred (300) utilities were surveyed consisting of the investor-owned, rural electric generation and transmission cooperatives, municipal power pools and federally chartered utilities. Of these utilities, 10 are Canadian and 7 are power pools. The rest are United States utilities having a peak demand on installed capacity above 200 MW. The survey was conducted by mailing a questionnaire and/or following up with a telephone call. Information was received from 282 utilities, a 94% response. 13 figs., 14 tabs.

19729 (Juel-Spez-521) **Status and development trends of electricity supply options in the Federal Republic of Germany - central and decentral.** Aktuelle Beitraege zur Energiediskussion. Kolb, G. Kernforschungsanlage Juelich GmbH (Germany, F.R.). Programmgruppe Systemforschung und Technologische Entwicklung. Sep 1989. 50p. Order Number DE90753514. Available from NTIS (US Sales Only), PC A03/MF A01.

The time horizon for the perspectives is the decade 2000 to 2010: For the nuclear sector (22.3 GW, 21 LWR) no further net expansion is expected. The German nuclear industry is now oriented to cooperation within the EC and to exports (advanced LWR, HT-GCR). The development of novel fossil fired power plants is (nearly) entirely focused on coal and lignite based concepts (integrated gasification combined cycle: IGCC, and combined cycle with pressurized fluidized bed combustion: PFBC-CC and in an early development status the pressurized coal dust fired combined cycle: PCDF-CC). Currently one experimental combined cycle with natural gas fired gas turbine, 2 pilot PFBC-CC stations and 6 pilot IGCC-CC-stations (2 with PFB, 3 with entrained flow, 1 with molten iron bath) are operative. Future regenerative main options are hydro, waste and wind. For the end of the century the expectations are about 5 GW hydro (from 3.8 GW in 1988 without pumped storage), 2 GW waste utilization and between a few hundreds MW and 1-2 GW of wind power, the latter being only a fuel saver. PV-prospects for decentral electricity look favorable up to a range of 1-1.5 mtce/a (3-4.5 TWh/a). The target for CO_2-reductions formulated at the Toronto Conference of 1988 for the year 2005 is not easily attainable for the FRG: Even total replacement of the present coal and lignite based capacities of the public utilities by advanced PFBC-CC stations could reduce their annual 220 mill. t CO_2 emissions only by about 40 mill. t CO_2/a, but by about 130 mill. t CO_2/a through replacement by natural gas fired combined cycle power plants. Complete deployment of the renewable electricity potential by replacing conventional coal fired stations could at maximum reduce CO_2-emissions by approx. 13-14 mill. t CO_2/a. (orig./UA).

19730 (LA–11728-C, pp. 3-9) **International cooperation in planning and preparing for nuclear accidents or radiological emergencies.** Asculai, E. (International Atomic Energy Agency, Vienna (Austria)). Los Alamos National Lab., NM (USA). Nov 1989. (CONF-8907103–: Conference on technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). In *Proceedings of the conference on technology-based confidence building: Energy and environment.* Order Number DE90004455. Available from NTIS, PC A23/MF A01.

In September 1986 a special session of the General conference of the International Atomic Energy Agency (IAEA) passed two conventions which relate to activities upon occurrence of nuclear accidents or radiological emergencies. These are: (1) The Convention on Early Notification of a Nuclear Accident and (2) The Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency. The requirements and implementation of the Conventions are discussed along with the IAEA role.

2980 Consumption and Utilization

Refer also to citation(s) 19703, 19706, 19707, 19724, 19727, 19820

19731 (ORNL/FTR–3525) **[Power sector efficiency in Costa Rica]: Foreign trip report, January 17, 1990–January 27, 1990.** MacDonald, J.M. Oak Ridge National Lab., TN (USA). 2 Feb 1990. 7p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. Order Number DE90007432. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The data on sectoral energy use are needed for the end use efficiency assessment portion of the overall efficiency initiative. Meetings were held with numerous organizations and individuals in the San Jose area. Several reports on characteristics of households and buildings, and projections of future energy use were obtained. The efficiency assessment is in good shape because of the quality of the data obtained, and this portion of the efficiency initiative should proceed with few difficulties because of the information received on the trip.

2990 Unconventional Sources and Power Generation

Refer also to citation(s) 19478

19732 **Evaluation of residential wood energy use in Idaho.** Force, J.E. (Idaho Univ., Moscow, ID (USA). Dept. of Forestry and Wildlife). pp. 504 of Proceedings of a international conference on residential wood energy. Zhejing University Press, Hangzhou, China (1986). (CONF-860323–: International conference on residential wood energy, Reno, NV (USA), 4-6 Mar 1986).

The author reports a random sample of Idaho households contacted by a mail survey in April 1985 to understand the use of wood energy for residential heating in the state. Responses were received from 774 households (71%). Wood is used as a main or secondary heat source in 57% of Idaho households and another 17% are considering adopting wood energy by 1990. On the average, wood users are younger than non-users (47 vs. 51 years); are more likely to live in rural areas; have larger families; and live in a single family home which they own. Forty percent of those considering adopting wood may do so even if there is no change or a decrease in the cost of their present fuel. Current wood users burned an average of 3.8 cords the winter of 1984-85. The most important reason they are burning wood is to save money on their heating bill.

19733 **The greenhouse effect: Energy conversion and conservation.** . Levine, M.D. (Lawrence Berkeley Lab., CA (USA)). pp. 935 of The Electrochemical Society Spring meeting (extended abstracts). The Electrochemical Society, Pennington, NJ (1989). (CONF-890518–: 175. meeting of the Electrochemical Society, Los Angeles, CA (USA), 7-12 May 1989).

The relationship between potential global warming and energy conversion and use will be of fundamental importance to energy researchers and policy makers alike over the next decades and longer. This paper provides a perspective on several key issues: in a business as usual scenario, how serious is global warming likely to be and over what time frame; what is the relative contribution of energy (versus deforestation and other activities) to global warming; and what is the importance of developing versus developed countries to the problem? The conclusion is that the potential gains from energy efficiency remain substantial and that the costs are affordable, but that very large efforts are needed – particularly in developing countries, which have very little experience in energy efficiency activities – if this option is to be effective. Data on China and elsewhere in Asia are presented to illustrate the magnitude of the efforts that are needed if serious gains in energy efficiency are to be made in developing nations.

30 DIRECT ENERGY CONVERSION

Refer also to citation(s) 21078

3001 MHD Generators

19734 (DOE/ID/12735–T5) **Cohesive ceramic fabrication: Quarterly progress report, June 1-August 31, 1989.** MSE, Inc., Butte, MT (USA). 1989. 24p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC07-88ID12735. Order Number DE90007333. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The project is separated into three tasks. The first task is a design and modeling effort to be carried out by MSE, Inc. The initial undertaking of Task 1 is the design of an advanced ceramic MHD electrode. The second task, subcontracted to Applied Technology Laboratories (ATL), is directed at characterizing the mechanical properties of monolithic and bonded ceramics produced with the cohesive ceramic fabrication (CCF) process. The third task, subcontracted to Ceramic Binder Systems, Inc. (CBSi), is to fabricate the components designed in Task 1 and to fabricate a model planar solid oxide fuel cell. These tasks are discussed separately in this report. Areas of technical progress included in this first quarterly report are: assessing design specifications for a hot ceramic MHD electrode; reviewing components suited for CCF process design demonstration; transferring the CCF process technology from

CBSi to MSE and ATL personnel; reviewing test methods suited to characterizing mechanical properties of CCF process ceramics; and fabricating individual components for a planar solid oxide fuel cell. 12 refs., 11 figs.

19735 (DOE/PC/79670–5) **MHD [Magnetohydrodynamics] recovery and regeneration: Phase 1, Evaluation of bench-scale results: Final report.** McIlroy, R.A. (Babcock and Wilcox Co., Alliance, OH (USA). Research Center); Probert, P.B.; Lahoda, E.J.; Swift, W.M.; Jackson, D.M.; Prasad, J.; Martin, J.; Rogers, C.; Ho, K.K.; Senary, M.K.; Lee, S. Babcock and Wilcox Co., Alliance, OH (USA). Research Center. Oct 1988. 268p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-87PC79670. Order Number DE90004175. Available from NTIS, PC A12/MF A01 - OSTI.

A two-phase program investigating MHD seed regeneration is described. In Phase I, bench scale experiments were carried out to demonstrate the technical feasibility of a proposed Seed Regeneration Process. The Phase I data has been used for the preliminary design of a Proof-of-Concept (POC) plant which will be built and tested in Phase II. The Phase I data will also be used to estimate the costs of a 300 Mw(t) demonstration plant for comparison with other processes. The Seed Regeneration Process consists of two major subprocesses; a Westinghouse Dry Reduction process and a modified Tampella (sulfur) Recovery process. The Westinghouse process reduces the recovered spent seed (i.e., potassium sulfate) to potassium polysulfide in a rotary kiln. The reduction product is dissolved in water to form green liquor, clarified to remove residual coal ash, and sent to the Tampella sulfur release system. The sulfur is released using carbon dioxide from flue gas in a two stage reaction. The sulfur is converted to elemental sulfur as a marketable by product. The potassium is crystallized from the green liquor and dried to the anhydrous form for return to the MHD unit.

3003 Thermoelectric Generators

19736 **Kinetics and transport at the sodium beta alumina/porous metal electrode interface.** Williams, R.M. (California Inst. of Tech., Pasadena, CA (USA). Karman Lab. of Fluid Mechanics and Jet Propulsion); Jeffries-Nakamura, B.; Underwood, M.L.; Bankston, C.P. pp. 935 of The Electrochemical Society Spring meeting (extended abstracts). The Electrochemical Society, Pennington, NJ (1989). (CONF-890518–: 175. meeting of the Electrochemical Society, Los Angeles, CA (USA), 7-12 May 1989).

The authors previously presented a model which includes the influence of both interfacial kinetics as well as free-molecular flow sodium gas transport on the behavior of the PME/BASE interface. By including ohmic resistances as well, current-voltage curves could be fit to a satisfactory degree of precision; and other experimental results could be interpreted. Fitting impedance data to a simple RC loop allowed extraction of the exchange current, transfer coefficient, and a mass transport parameter which accurately describes steady-state diffusion of sodium through the electrode. However, the mechanistic basis of the magnitude of the transport parameter, and the complete frequency response of the electrode have not been adequately explained in all cases. They discuss a variety of electrodes consisting of Mo, W, W-Rh, or W–Pt magnetron sputtered thin films 0.5-10.0 μm thick investigated by several techniques at operating temperatures up to ~1220 K. Mature electrodes, essentially free of oxide films, and with a reasonably stable microstructure, were obtained after about twenty-four hours at operating conditions. Current-voltage curves, impedance spectroscopy, transient response techniques and sheet resistance measurements give a fairly complete characterization of each electrode, and these techniques were utilized over the AMTEC cell operating temperature range. Electrode microstructure is investigated in detail following each experiment.

19737 **Liquid metal thermal electric converter.** Abbin, J.P.; Andrake, C.E.; Lukens, L.L.; Moreno, J.B. To Dept. of Energy, Washington, DC. USA Patent 4,868,072. 19 Sep 1989. Filed date 28 Jul 1988. USA Patent Application 7 225,442. Int. Cl. H01M 10/39; H01M 14/00. 10p. Available from Patent and Trademark Office, Box 9, Washington, DC 20232.

This patent describes a liquid metal thermal electric converter which converts heat energy to electrical energy. The design of the liquid metal thermal electric converter incorporates a unique configuration which directs the metal fluid pressure to the outside of the tube which results in the structural loads in the tube to be compressive. A liquid metal thermal electric converter refluxing boiler with series connection of tubes and a multiple cell liquid metal thermal electric converter are also provided.

3004 Thermionic Converters

Refer also to citation(s) 20965

19738 (MLM–3625-OP) **Current helium venting technology for $^{238}PuO_2$ heat sources.** Johnson, E.W. EG and G Mound Applied Technologies, Miamisburg, OH (USA). [1990]. 4p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-88DP43495. (CONF-900109–23: 7. symposium on space nuclear power systems, Albuquerque, NM (USA), 7-11 Jan 1990). Order Number DE90007149. Available from NTIS, PC A02/MF A01 - OSTI.

Subsequent to the early flight programs that used sealed capsules containing plutonium-238 metal/alloy fuels (SNAP-3 and -9A), heat sources for radioisotope thermoelectric generators (RTGs) in space have employed venting mechanisms to allow helium to escape from the interior of the metallic containment. Vent uses range from a planned post-life activation (SNAP-27), a tube venting scheme which prevents introduction of helium into the thermoelectric area (SNAP-19 and Multi-Hundred Watt), and direct venting of the helium into the RTG internal area (GPHS). The manufacturing of iridium vents for the General Purpose Heat Source (GPHS) program and the passive in-situ reduction of the plutonium dioxide fuel and helium management will be discussed. Also, the venting practice for one-watt heater units and their manufacturing techniques are discussed. 3 refs., 1 fig.

19739 **Computer simulation of the plasma-filled diode.** Geary, J. (Berkeley Research Associates, Springfield, VA (USA)). pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The plasma-filled diode (PFD) consists of a low density plasma injected into a diode in a pulsed-power device. The PFD has been used as a prepulse suppression switch and as a combination opening switch/e-beam diode for use in inductive energy storage devices. The plasma initially provides a low impedance load. However as the current increases, the impedance eventually rises rapidly opening the switch. The behavior of this device is examined using the 2 1/2 D electromagnetic particle code ISIS developed at LANL. A TEM wave is launched down a coaxial transmission line that feeds into a PFD. Particle emission is allowed from the electrodes in an azimuthally symmetric cylindrical (r-z) geometry. This investigation includes an examination of the magnetic field penetration of the plasma, the motion of the electron beam, and the formation of sheaths at the electrodes. The plasma density and injection speed are varied as are wave parameters.

3005 Fuel Cells

Refer also to citation(s) 19630, 19711, 20005

19740 (CONF-890572–1) **Solid-state proton conductors.** Remick, R.J.; Jewulski, J.; Osif, T. Institute of Gas Technology, Chicago, IL (USA). [1989]. 5p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-88MC24218. From 1. annual fuel cells contractors review meeting; Morgantown, WV (USA); 2-4 May 1989. Order Number DE90007595. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Work on this project is divided into three tasks. In the first, a comprehensive literature review was performed for the purpose of collecting data on solid proton conductors. The data was then analyzed with the goal of correlating physical and chemical characteristics with protonic conductivity in order to gain a better understanding of the phenomenon. In the second task, the results of the correlation study were used to choose an electrolyte system in which to work and to aid in the formulation of new candidate

proton conductors. Under the third task, a universal test stand was constructed which can measure both electronic and protonic conductivity and which can be converted to use as a solid state fuel cell test stand. Samples of doped $SrCe_{0.95}Yb_{0.05}O_3$ have been coated with palladium electrodes and the mechanism responsible for ionic conductivity through this material is currently under study. 6 refs., 1 fig.

19741 (DOE/MC/23139–2794) **Zirconia-based electrodes for solid oxide fuel cells: Final report.** Worrell, W.L. Pennsylvania Univ., Philadelphia, PA (USA). Dept. of Materials Science and Engineering. Dec 1989. 9p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG21-86MC23139. Order Number DE90000462. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The objective of this contract is the syntheses and electrical characterization of new mixed-conducting yttria-stabilized zirconia-titania solutions. The results will provide the fundamental data necessary for the quantitative evaluation of the potential electrode applications of these new mixed conducting oxides in solid oxide fuel cells (SOFC). 4 refs., 6 figs.

19742 (DOE/MC/24223–2792) **Gas cooled fuel cell systems technology development program: Quarterly report, September–November 1989.** Feret, J.M. Westinghouse Electric Corp., Pittsburgh, PA (USA). Advanced Energy Systems Div. Dec 1989. 37p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-82MC24223. Order Number DE90000446. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report addresses the fourth logical unit of work of a multi-year program whose overall objective is the development of a gas-cooled phosphoric acid fuel cell (PAFC) for electric utility power plant application. This PAFC Technology Development Program continuation is structured to build upon the current cell technology baseline so as to advance critical component technologies to meet the performance, endurance, reliability and cost goals associated with successful energy service. Progress is described.

19743 (N–90-11804) **The fuel cell in space: Yesterday, today and tomorrow.** Warshay, M.; Prokopius, P.R. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Sep 1989. 11p. (NASA-TM–102366;E–5084;NAS–1.15:102366;CONF-8909301–: Grove anniversary (1839-1989) fuel cell symposium, London (UK), 18-21 Sep 1989). Available from NTIS, PC A03/MF A01.

The past, present, and future of space fuel cell power systems is reviewed, starting with the first practical fuel cell by F.T. Bacon which led to the 1.5 kW Apollo alkaline fuel cell. However, the first fuel cell to be used for space power was the Gemini 1.0 kW Acid IEM fuel cell. The successor to the Apollo fuel cell is today's 12 kW Orbiter alkaline fuel cell whose technology is considerably different and considerably better than that of its ancestor, the Bacon cell. And in terms of specific weight there has been a steady improvement from the past to the present, from the close to 200 lb/kW of Apollo to the 20 lb/kW of the orbiter. For NASA future Lunar and Martian surface power requirements the regenerative fuel cell (RFC) energy storage system is enabling technology, with the alkaline and the PEM the leading RFC candidate systems. The U.S. Air Force continues to support fuel cell high power density technology development for its future short duration applications.

19744 Fuel cells for transportation. Lemons, R.A. (Los Alamos National Lab., NM (USA)). pp. 935 of The Electrochemical Society Spring meeting (extended abstracts). The Electrochemical Society, Pennington, NJ (1989). (CONF-890518–: 175. meeting of the Electrochemical Society, Los Angeles, CA (USA), 7-12 May 1989).

The author discusses how fuel cells offer an attractive alternative power source for transportation applications. They provide over twice the efficiency of internal-combustion engines and can operate on non-petroleum-based fuel, such as methanol. Significant advances made in increasing the power density and reducing the intrinsic cost of fuel cells is described. According to the author much work remains before they can successfully be integrated into vehicles on a large scale.

19745 Fuel cells based on the direct oxidation of methanol. Gottesfeld, S. (Los Alamos National Lab., NM (USA). Electronics Div.). pp. 935 of The Electrochemical Society Spring meeting (extended abstracts). The Electrochemical Society, Pennington, NJ (1989). (CONF-890518–: 175. meeting of the Electrochemical Society, Los Angeles, CA (USA), 7-12 May 1989).

A description is given of anode alloys recently tested that exhibit good CO tolerance -a property closely related to tolerance with respect to surface poisons in methanol electro-oxidation - as well as some alloys tested in fuel cells based on direct methanol oxidation. Work done on the characterization of such alloy surfaces is described. The main points addressed are: characterization of the alloy surface by in situ and ex situ measurements to identify the early onset of surface oxide (or hydroxide) formation and probe its reactivity with respect to absorbed CO and testing of the stability of the alloy surface with respect to deal-loying processes which, if take place, may alter significantly the electrocatalytic activity. A new approach to the problem of Pt anode poisoning by CO which has been identified recently is described. Injection of small amounts of oxygen into a hydrogen anode feed contaminated by CO turned out to be an effective way to generate a surface oxidative environment required to remove absorbed CO. This paper describes the performance of PEM fuel cell with anode feed streams containing CO levels of 100, 500, and 1000 ppm, before and after the injection of O_2 into the anode at levels ranging from 1%-14%.

19746 Kinetics of oxygen reduction and hydrogen oxidation at the platinum/ionomeric membrane interface. Raistrick, I.D. (Los Alamos National Lab., NM (USA). Electronics Div.); Springer, T.E.; Sherman, R.J.; Gottesfeld, S. pp. 935 of The Electrochemical Society Spring meeting (extended abstracts). The Electrochemical Society, Pennington, NJ (1989). (CONF-890518–: 175. meeting of the Electrochemical Society, Los Angeles, CA (USA), 7-12 May 1989).

The proton-exchange membrane (PEM) fuel cell has received significant attention recently, thanks mainly to a demonstration of the high power densities obtainable from it. High performances were demonstrated in PEM cells that contain low Pt loadings, operated on H_2 and air. The latter capability, combined with the perfect tolerance to CO_2 and the low temperature of operation, makes this fuel cell a prime candidate for development as a power source for transportation applications. This paper reviews the efforts to elucidate the factors which control the rates of the interfacial processes in this cell. The authors describe their measurement of the kinetics of the fuel cell processes in single PEM cells and for some model Pt/Nafion interfaces.

19747 Investigations of enzyme-modified electrodes with electrochemical and quartz-crystal microbalance measurements. Rishpon, J. (Los Alamos National Lab., NM (USA). Electronics Div.); Gottesfeld, S. pp. 935 of The Electrochemical Society Spring meeting (extended abstracts). The Electrochemical Society, Pennington, NJ (1989). (CONF-890518–: 175. meeting of the Electrochemical Society, Los Angeles, CA (USA), 7-12 May 1989).

Electrodes used for the sensitive detection of glucose in various biological solutions have been developed in many laboratories. However, the successful implementation of such electrodes for the monitoring of physiological or biotechnological processes has not yet been achieved. The availability of an additional non-electrochemical tool for the characterization of enzyme modified electrodes, while immersed in the biological solution tests, could provide valuable information. One such tool that has been developed recently and seems to have good potential to provide such information is the quartz-crystal microbalance (QCMB). This tool is capable of measuring variations in the mass of an immersed electrode with sensitivity of the order of 10 nanograms per cm^2 of electrode area. In this work the authors systems of enzymes immobilized in conducting polymer films. Their potential important advantage is the possibility that the redox component in the conducting polymer could become an active electron-mediating system allowing not only high efficiency of the immobilized enzyme but also the possibility to obtain a glucose electrode that would not require oxygen for its continuous stable functioning. The authors describe details of electrochemical and QCMB measurements on

various films with immobilized enzymes, stressing the system of glucose oxidase immobilized in polyrrole. The growth of the film and its response in the presence and in the absence of dissolved oxygen is described for layers grown at Pt electrodes attached to a QCMB system.

32 ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

Refer also to citation(s) 20099

3201 Buildings

Refer also to citation(s) 19230, 19510, 19511, 19572, 19623, 19731, 19798, 19810, 19934

19748 (AD-A–214171/1/XAB) **Guidelines for evaluating energy-analysis software. Final report.** Lawrie, L.; Bahnfleth, W. Army Construction Engineering Research Lab., Champaign, IL (USA). Sep 1989. 61p. (CERL-TR-E–89/15). Available from NTIS, PC A04/MF A01.

Design criteria documents used by Army designers require that an energy analysis of buildings be performed during the design process. However, designers are given little guidance either on modeling buildings of energy analysis or on using computer programs to perform the analysis. This report describes methods designers can use to evaluate energy-related software used for whole-building energy analysis and provides an Energy Analysis Calculation Tool Worksheet to use during evaluation. The suitability of an energy-analysis program depends to a large extent on the intended use. Rather than using a separate program for each application, it may be better to learn a very detailed program that will be suitable for all applications. Agreement between programs during evaluation does not guarantee agreement with real data. The program's successful solution of a simple problem may not be a good indicator of its ability to give similar accuracy for a complex problem. Energy Analysis is the process of estimating energy requirements and fuel consumption of heating, ventilating, and air conditioning, electrical, and other consuming systems for either short or long terms of operation. Three common elements associated with building energy analysis are the calculation of: (l) space load, (2) secondary-equipment load, and (3) primary-equipment energy requirements. Here, secondary refers to the equipment that distributes the heating, cooling, or ventilating medium to the conditioned spaces, while primary refers to the central-plant equipment that converts fuel or electric energy to the heating or cooling effect.

19749 (BRE-IP–19/89) **Condensing boilers: reduced space-heating costs in large residential buildings.** Trim, M.J.B. Building Research Establishment, Watford (UK). Nov 1989. 4p. Order Number DE90752720. Available from NTIS (US Sales Only), PC A02/MF A01.

Owners of buildings in which space heating is provided by centralised, gas-fired heating plants can reduce their heating costs through the use of highly efficient heating appliances known as condensing boilers. This paper is based on a monitoring programme in sheltered housing in which condensing boilers were used to provide the space heating. The results will be of interest to heating installers, building services engineers, housing authorities and operators and designers of large buildings in which centralised heating plant is used to provide the heating services. (author).

19750 (CONF-891202–10) **A regression method for calculating the thermal performance of basement, crawl space, and slab-on-grade foundations.** Shen, L.S.; Bigot, P.A.; Huang, Y.J.; Christian, J.E. Oak Ridge National Lab., TN (USA). [1989]. 19p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. From 4. thermal performance of the exterior envelopes of buildings; Orlando, FL (USA); 4-7 Dec 1989. Order Number DE90007127. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A set of regression equations has been developed for calculating heating and cooling season loads and energy use for the basement, crawl space, and slab-on-grade constructions described in the Building Foundation Design Handbook (Labs et al. 1988). The building load and energy use data based were developed for the Handbook using a finite difference computer program coupled with the DOE 2.1C whole building energy-use simulation model. Twenty-seven different insulation configurations and conditions were simulated for 13 US cities representing major climatic regions. The regression equations calculate the annual and seasonal loads and energy use as functions of the local climatological data and the insulation thermal resistance. The general applicability of the regression equations is also discussed. 10 refs., 6 figs., 8 tabs.

19751 (CONF-9004134–1) **Planning building energy monitoring field tests.** Ternes, M.P. Oak Ridge National Lab., TN (USA). [1990]. 5p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. From Field monitoring for a purpose conference; Gothenburg (Sweden); 2-5 Apr 1990. Order Number DE90007128. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Although a detailed planning step is vital to the development of a successful building energy monitoring field test, such a step is often overlooked. An eight part planning process is outlined in this paper that starts with the identification of research questions and uses these as the basis to identify field data and collection hardware. Knowledge of individual aspects of project design are used through the process. An experimental plan, which documents this planning work, should be developed for all field projects. This process has been successfully used by the author in designing several experiments and helps ensure that a project meets clearly defined objectives within available project resources. 3 refs.

19752 (DOE/OR/21548–082-Rev.2) **Evaluation of radon emissions and potential control requirements: For the Weldon Spring Site Remedial Action Project, Weldon Spring, Missouri: Revision 2.** MK-Ferguson Co., St. Charles, MO (USA); Jacobs Engineering Group, Inc., St. Charles, MO (USA). Jan 1990. 98p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-86OR21548. Order Number DE90007223. Available from NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

This report provides estimates of radon release rates at the Weldon Spring Quarry (WSQ) for existing conditions and conditions which are expected to exist as the bulk waste is excavated. It also estimates radon release rates for the Temporary Storage Area (TSA). In 1989, Rn-222 concentrations at the fence line exceeded DOE guidelines. Data on working level concentrations at one monitoring station indicate an effective whole body dose rate of 0.75 mrem/hr for radon daughters and 0.74 mrem/hr for thoron daughters at one meter above the quarry waste. Since some of the calculations are based on assumptions, they show only the relative difference in radon release between present conditions and either of two excavation scenarios. They can be used in calculations of public exposure and potential health effects to evaluate the relative merit of each excavation scenario in comparison with present release conditions. The model used to make the estimates in this report is useful for estimating the radon release rate for the entire period of excavation, but it is not suitable for estimating worker exposure over short periods of time. Therefore, worker exposure and appropriate requirements for personal protective equipment will be determined as the excavation proceeds. 6 refs., 3 figs., 13 tabs.

19753 (EEO-ED–37/89) **Low energy houses in the city of Manchester: A demonstration at Manchester City Council.** Department of Energy, London (UK). Energy Efficiency Office; Manchester Univ. (UK). Inst. of Science and Technology. [1989]. 53p. Order Number DE90752752. Available from NTIS (US Sales Only), PC A04/MF A01.

Energy Efficiency Demonstration Scheme report for The Building Research Energy Conservation Research Unit (BRECSU), Building Research Establishment, Watford (GB).

In 1980, Manchester City Council approved the construction of 15 Low Energy Houses as part of the Halliwell Lane redevelopment in Cheetham, North Manchester. The Council's need was for a coherent package of compatible, energy saving design measures capable of reasonably prompt large scale application and free from excessive reliance on complex equipment. The design of these houses concentrated upon simplicity of form and installation but gave very careful attention to the effects upon thermal performance

of the form, fenestration, planning and materials of construction and to workmanship. (author).

19754 (EEO-ED-107/170) **An integrated design for energy efficient co-operative housing: A demonstration at Giffard Park, Milton Keynes.** Horton, A. (Open Univ., Milton Keynes (UK). Energy Research Group). Department of Energy, London (UK). Energy Efficiency Office. Oct 1986. 49p. Order Number DE90752747. Available from NTIS (US Sales Only), PC A03/MF A01.

Energy Efficiency Demonstration Scheme report for The Building Research Energy Conservation Research Unit (BRECSU), Building Research Establishment, Watford (GB).

In 1980 the Society for Cooperative Dwellings Ltd. commissioned the ECD Partnership to design a low energy housing developing at Giffard Park, Milton Keynes, intended mainly for single people and couples. The buildings were completed and occupied in July 1984. The design approach was to incorporate a package of proven energy-saving measures that would achieve substantial and cost-effective reductions in fuel requirements compared to the same buildings designed simply to meet the minimum requirements of the 1982 Building Regulations. This package included: passive solar design; increased levels of insulation in the walls and roof; the addition of floor insulation; measures designed to reduce air infiltration and individual room heaters rather than central heating. In addition insulating blinds were fitted to one terrace and a novel solar passive water heating system was fitted to four houses, both as experimental measures. (author).

19755 (EEO-ED-179/59) **The Salford low-energy house: A demonstration at Strawberry Hill, Salford.** Webster, P.J. (Salford Univ. (GB). Dept. of Civil Engineering). Department of Energy, London (UK). Energy Efficiency Office; Salford Civil Engineering Ltd. (UK). Dec 1987. 57p. Order Number DE90752748. Available from NTIS (US Sales Only), PC A04/MF A01.

Energy Efficiency Demonstration Scheme report for The Building Research Energy Conservation Research Unit (BRECSU), Building Research Establishment, Watford (GB).

A low-energy house project was undertaken jointly by Salford City Council and Salford University to help resolve local housing problems by the practical application of scientific research and technology available at the University. The aim of the project was to provide housing which retained the comforts and convenience of traditionally designed homes but which had a low energy consumption, maximum flexibility of energy source, minimum maintenance and eliminated serious condensation. (author).

19756 (EEO-ED-200/223) **Demonstration of low energy housing for elderly people at Peterloo Court, Salford.** Graham, J.A. (Ove Arup and Partners, Manchester (GB)). Department of Energy, London (UK). Energy Efficiency Office. Sep 1987. 33p. Order Number DE90752751. Available from NTIS (US Sales Only), PC A03/MF A01.

Energy Efficiency Demonstration Scheme report for The Building Research Energy Conservation Research Unit (BRECSU), Building Research Establishment, Watford (GB).

In April 1985 Ove Arup and Partners, Manchester office, were commissioned by the Building Research Energy Conservation Support Unit (BRECSU) to monitor a low energy sheltered housing development for the elderly at Peterloo Court, Salford. The scheme had been selected as a Demonstration Project under the Department of Energy's Energy Efficiency Demonstration Scheme (EEDS), administered by BRECSU. The integrated package of energy saving measures included: high levels of insulation in floors, walls and roofs; double glazing; draught-stripping; and greatly simplified heating system. (author).

19757 (EEO-ED-208/245) **Low cost full house heating in low energy housing: A demonstration for Manchester City Council.** Brewerton, I. (Manchester City Council (GB)). Department of Energy, London (UK). Energy Efficiency Office. Jul 1989. 44p. Order Number DE90752746. Available from NTIS (US Sales Only), PC A03/MF A01.

Energy Efficiency Demonstration Scheme report for The Building Research Energy Conservation Research Unit (BRECSU), Building Research Establishment, Watford (GB).

The installation, by Manchester City Council, of an experimental simplified heating system in a group of low energy houses at Collyhurst, Manchester has resulted not only in comfort levels and design temperatures more normally associated with traditional whole-house heating systems, but also in energy savings for space and hot water heating. Savings were determined by comparing energy use and energy costs for the experimental houses with those for a control group of identical houses fitted with a standard central heating system. Savings ranged from 8% in the summer to 14-16% during the heating season, and the total average saving of 6.33 GJ/year (60 therms/year) was worth almost Pound 22/year to the occupants at 1987 gas prices of Pound 3.44/GJ (Pound 0.363/therm). (author).

19758 (EEO-ED-227/209) **Energy efficient refurbishment of Victorian terraced housing: A demonstration for Merseyside Improved Houses, Liverpool.** Sluce, A.J.A. (BDP Energy and Environment, Manchester (GB)); Tong, D. Department of Energy, London (UK). Energy Efficiency Office. [1989]. 51p. Order Number DE90752753. Available from NTIS (US Sales Only), PC A04/MF A01.

Energy Efficiency Demonstration Scheme report for The Building Research Energy Conservation Research Unit (BRECSU), Building Research Establishment, Watford (GB).

Energy savings worth an average of Pound 41/year, together with improved comfort levels and reduced maintenance requirements, have been achieved in this demonstration by Mersyside Improved Houses. The demonstration, which was supported under the Energy Efficiency Office's Energy Efficiency Demonstration Scheme, involved the installation of a package of energy-saving measures in 24 solid-walled terraced houses in an inner-city area of Merseyside. These were in addition to the normal energy-related measures (central heating and roof insulation) installed during refurbishment of houses to the standard level for 1985. The additional measures comprised: internal insulation of external walls; draught-stripping of external doors and windows; double glazing of downstairs living rooms; and extract fans in kitchens and bathrooms. (author).

19759 (EEO-ED-250/212) **Shenley Hospital condensing boilers: A demonstration for Parkside Health Authority.** Lillywhite, M. (Building Research Establishment, Watford (GB). Building Energy Conservation Research Unit (BRECSU)); Leach, S.J. Department of Energy, London (UK). Energy Efficiency Office. Mar 1989. 22p. (BRS-75/89). Order Number DE90752749. Available from NTIS (US Sales Only), PC A03/MF A01.

Energy Efficiency Demonstration Scheme report for The Building Research Energy Conservation Research Unit (BRECSU), Building Research Establishment, Watford (GB).

In 1983 Doy Webster Partnership were commissioned by Parkside (formerly Brent) Health Authority to carry out an Extended Energy Survey (with 50% Energy Efficiency Office funding) of the Shenley Hospital site at Radlett, Hertfordshire. Shenley Hospital comprises 60 widely dispersed buildings on a 75 hectare site. A major recommendation from the survey was for the installation of new gas fired boiler plant for space heating. Condensing boilers give high efficiencies by recovering extra heat from the flue gases by using an enlarged heat exchanger surface. They recover extra sensible heat at all times and when the water system temperatures are low, recover latent heat through condensation of water in the flue gas on the heat exchanger. (author).

19760 (EEO-RD-41/38) **Monitoring and targetting in local authority buildings: A review of current practice.** Butler, T. (Atkins (W.S.) and Partners, Epsom (UK)). Department of Energy, London (UK). Energy Efficiency Office. Apr 1988. 25p. Order Number DE90752750. Available from NTIS (US Sales Only), PC A03/MF A01.

Energy Efficiency R and D Project interim report for The Building Research Energy Conservation Research Unit (BRECSU), Building Research Establishment, Watford (GB).

The Building Research Energy Conservation Support Unit (BRECSU), funded by the Department of Energy, is looking at how monitoring and targeting of energy consumption is practised in local authority buildings with a view to encouraging the development of improved techniques. The research has shown that an Energy

Unit is an essential element of a successful energy efficiency programme. This Unit needs a monitoring system and should set targets for individual buildings to make the energy consumed accountable. Another important aspect of saving energy in a local authority is 'Getting the Message Across' - a method which can be backed up by a variety of incentive schemes. (author).

19761 (EPRI-CU–6606) **Proceedings: Electric alternatives to commercial cogeneration.** Mahany-Braithwait, C.L. (ed.) (Barakat, Howard and Chamberlin, Inc., Oakland, CA (USA)). Electric Power Research Inst., Palo Alto, CA (USA); Barakat, Howard and Chamberlin, Inc., Oakland, CA (USA). c Jan 1990. 536p. Sponsored by Electric Power Research Institute. (CONF-881089–: Electric alternatives to commercial cogeneration, San Diego, CA (USA), 19-21 Oct 1988). Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

These proceedings document a seminar, "Electric Alternatives to Commercial Cogeneration," held in San Diego, California, October 19–21, 1988. This seminar was held to present the latest information on technological, financial, and service end-use energy options available to today's commercial building owner. Information was provided on currently available high-efficiency electric end-use equipment, load management technologies, commercial cogeneration systems, pricing, service and financing options, market strategies, and competitive assessment techniques. Attendees included utility representatives from marketing, rate development, technical, and management areas.

19762 (EPRI-CU–6643) **Expected energy use of ice storage and cold air distribution systems in large commercial buildings: Final report.** Hittle, D. (Purdue Univ., Lafayette, IN (USA). Ray W. Herrick Labs.); Bhansali, A. Electric Power Research Inst., Palo Alto, CA (USA); Purdue Univ., Lafayette, IN (USA). Ray W. Herrick Labs. Feb 1990. 53p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

High-rise commercial buildings have a potential for effectively using cool storage due to their cooling load profiles. This study discusses the use of cold air distribution systems (43 F) in conjunction with ice storage as a means to further reduce peak power and energy consumption. An assessment was made of whether or not energy or cost savings could be achieved when applying these systems to a prototypical office building in six different climate regions. A description of the building and its HVAC system is presented. An algorithm for modeling the performance of an ice harvester was developed and used in conjunction with the Building Loads Analysis and System Thermodynamics (BLAST) computer program to simulate system performance. Four utility rate structures were used to determine the impact of rate variations on annual operating costs. These results are discussed and recommendations for further work are provided.

19763 (EPRI-CU–6690-Vol.1) **Detailed field evaluation of a cold air distribution system: Volume 1, Study and results, Final report.** Dorgan, C.E. (Dorgan Associates, Inc., Madison, WI (USA)); Elleson, J.S.; Downey, M.S. Electric Power Research Inst., Palo Alto, CA (USA); Dorgan Associates, Inc., Madison, WI (USA). c Feb 1990. 43p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

A cold air distribution system on a typical floor of a 12-story office building in southern California was instrumented, and detailed data were collected for a 7-month period. The system was designed to supply 45°F–49°F primary air from an ice storage cooling system. It was found that supply fan energy was 38% less than for a conventional 55°F supply air system. However, the energy consumption of the continuously operating fan-powered mixing boxes of the system, with their relatively inefficient fractional-horsepower motors and small fans, offset the supply fan energy savings. Energy consumption was calculated for several alternative approaches to supply air mixing and distribution, and recommendations for needed research are given. Volume 1 contains descriptions of the system and the monitoring approach, and results and conclusions. Complete data are provided in graphical form in Volume 2. 15 figs.

19764 (IE-MOEI–87/0100 vp, paper 6) **Insulating materials for buildings and industry based on light mineral aggregate.** Lin, I. (Technion - Israel Inst. of Tech., Minerals Engineering Research Center, Haifa (Israel)). Ministry of Energy and Infrastructure, Jerusalem (Israel). Oct 1987. (In Hebrew). (CONF-8710511–: ENTEC 87: 1. Israeli conference on technologies in energy, Tel Aviv (Israel), 28 Oct 1987). In *ENTEC 87. First Israeli conference on technologies in energy.* Available from COSTI P.O.B 20125, TEL-AVIV 61201.

Abstract only.

Properties of the natural and synthetic mineral aggregates, which are used in Israel as thermal insulation materials for buildings, are summarized. Light concrete, based on perlite or vermiculite, is used for roof insulation. It weighs 360-750 kg per m^3 and has thermal conductivity of 0.086-0.22 W/m.degree C. Perlite-based thermal plaster has thermal conductivity of 0.81 and helps to reduce building costs because of its easy workability. Perlite and vermiculite provide good acoustic insulation, with thermal conductivities of 0.04 and 0.06, and have good fire resistance. Perlite or vermiculite cements provide good fire resistance. In the metallurgical industry, raw mineral preparations spread on metallic surfaces provide thermal insulation and prevent oxidation. (MR)

19765 (MOEI-EC–1-89 YUD 1-YUD 89) **Economic aspects of building envelope insulation.** Dvoskin, D.; Yakir, A.; Linik, O.; Albintser, Y. Ministry of Energy and Infrastructure, Jerusalem (Israel). Energy Conservation Div.; Heshev, Tel Aviv (Israel). Inter-Kibbutz Unit for Management Services. Feb 1989. (In Hebrew). In *Guide to energy conservation in residential buildings. Climatic aspects, architectural design, building envelope design and economical aspects.* Available from COSTI P.O.B 20125, TEL-AVIV 61201.

Order with complete bibliographic information.

The requirement for an energy-saving investment to be economically worth while is that the cost of the investment and the energy cost during the remaining life of the building should be less than the energy cost would have been in the absence of the investment. The sections of the paper discuss the various aspects of the economic analysis involved in evaluating such investments. The section headings are: Model for economic analysis of the profitability of insulation in residential buildings. Assumptions and data for economic analysis. Economic findings, introduction. Economic findings, overall value of thermal insulation. Economic findings: investments in walls, roofs and floors. Profitability of wall insulation in the various climatic zones. Profitability of roof insulation according to region. Profitability of floor insulation. (RP) 46 tabs.

19766 (ORNL/M–1067) **Cooling season energy measurements of dust and ventilation effects on radiant barriers.** Levins, W.P. (Oak Ridge National Lab., TN (USA)); Karnitz, M.A.; Hall, J.A. Oak Ridge National Lab., TN (USA). Feb 1990. 50p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. Order Number DE90007190. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

Cooling season tests were conducted in three unoccupied ranch-style houses in Karns, Tennessee, to determine the effects on attic radiant barrier performance incurred by changes in attic ventilation area ratio, attic ventilation type, and the buildup of dust on horizontal radiant barriers. All three houses had R-19 fiberglass batt insulation in their attics. Horizontal radiant barriers were artificially dusted and the dusted barriers showed measurable performance degradations, although the dusted barriers were still superior to no radiant barriers. Dust loadings of 0.34 and 0.74 mg/cm^2 reduced a clean radiant barrier surface emissivity of 0.055 to 0.125 and 0.185, respectively. Total house cooling load increases amounted to 2.3 and 8.4% compared to house loads with clean horizontal barriers, respectively. When compared to R-19 with no horizontal radiant barrier conditions, the dusted horizontal radiant barriers reduced cooling loads by about 7%. 18 refs., 18 figs., 30 tabs.

19767 (ORNL/Sub–88-SA407/1) **Catalog of thermal bridges in commercial and multi-family residential construction.** Tuluca, A.N. (Winter (Steven) Associates, Inc., New York, NY (USA)); Evans, D.M.; Kumar, D.; Krarti, M.; Childs, K.; Courville, G.; Vonier, T.; Tye, R. Oak Ridge National Lab., TN (USA); Winter (Steven) Associates, Inc., New York, NY (USA). Dec 1989. 162p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE

Contract AC05-84OR21400. Order Number DE90005819. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

The catalog comprises a collection of 21 thermal bridges commonly encountered in commercial buildings, as well as alternative construction techniques which reduce the deleterious effects of these bridges. The thermal bridges presented here are conduction-dominated. Construction details which transfer heat mostly through convection or radiation are not addressed. The benefits of the alternate designs are expressed for each thermal bridge as (1) reductions in U-values and (2) reductions in moisture condensation. These reductions, in turn, are extrapolated at the whole building level in order to predict changes in the energy used for space heating and cooling and to estimate changes in the magnitude of the surface areas affected by moisture condensation. Finally, technical notes address the probable effects (thermal and moisture) of minor variations in the construction details presented in this catalog. The technical notes also give a more detailed prediction of the potential for moisture condensation due to thermal bridging.

19768 (PB–90-129925/XAB) **Development of an efficient, low-NOx domestic gas range cooktop. Phase 3. Final report, January 1986-December 1988. Technical report.** Shukla, K.C.; Hurley, J.R.; Grimanis, M.P. TECOGEN, Inc., Waltham, MA (USA). Oct 1989. 73p. (TR–7020-147-89). Available from NTIS, PC A04/MF A01.

See also report for Phase 3, Jan-Dec 86, PB–88-181284.

The objective of the program was to develop a domestic cooktop with low-NOx emissions and high efficiency. During the first two phases of the program, three design concepts were developed, and two versions of developmental prototypes using the IR-Jet approach were fabricated and tested. The third phase was initiated to address the design issues of a simmer setting, air/gas metering, and jet plate durability and to develop prototypes for interested manufacturers.

19769 (PB–90-129974/XAB) **Phase 1-supplemental development of a kinematic Stirling/Rankine commercial gas-fired heat-pump system. Final report, January 1989-June 1989.** Monahan, R. Stirling Power Systems Corp., Ann Arbor, MI (USA). Jun 1989. 50p. Available from NTIS, PC A03/MF A01.

See also PB–89-126239.

The kinematic Stirling/Rankine gas heat pump concept is based on the application of a Stirling engine that has been under development for over a decade. The engine has been converted to natural gas and is characterized with many thousand hours of operating experience. The goal of the project is to develop a commercial size Stirling engine-driven gas heat pump with a cooling capacity of 10 tons, a COP (heating) of 1.8 and a COP (cooling) of 1.1. The project is a multi-phase development with commercialization planned for the mid-1990's. In previous phases, an HVAC-systems manufacturer (York International) had been working with SPS to develop a prototype gas-heat-pump system. To date, two generations of prototype GHP systems have been built and tested and have demonstrated significant operating cost savings over the conventional electric heat pump. Under the program, a number of design and manufacturing process changes were made to the engine to reduce costs and improve endurance and shaft efficiency and are described. The adaptation and operation of a computer optimization code was accomplished under the program and is reported herein.

19770 (PNL–6971) **The technical and economic feasibility of establishing a building system integration laboratory.** Crawley, D.B.; Drost, M.K.; Johnson, B.M. Pacific Northwest Lab., Richland, WA (USA). Sep 1989. 96p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC06-76RL01830. Order Number DE90007606. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

On December 22, 1987, the US Congress provided funding to the US Department of Energy (DOE) "to study the feasibility and conceptual design of a whole building system integration laboratory" (Title II of Pub. L. 100–202). A whole-building system integration laboratory would be a full-scale experimental facility in which the energy performance interactions of two or more building components, e.g., walls, windows, lighting, could be tested under actual operating conditions. At DOE's request, the Pacific Northwest Laboratory (PNL) conducted the study with the assistance of a technical review and representing other federal agencies and the academic and private sectors, including professional societies, building component manufacturers, and building research organizations. The results of the feasibility study are presented in this report.

19771 Air exchange rates in a residence using wood before and after house tightening and the implications on indoor air quality. Parker, G.B. (Battelle Pacific Northwest Lab., Richland, WA (USA)). pp. 504 of Proceedings of a international conference on residential wood energy. Zhejing University Press, Hangzhou, China (1986). (CONF-860323–: International conference on residential wood energy, Reno, NV (USA), 4-6 Mar 1986).

In this paper, the author describes techniques used for measuring air exchange rates in a single family detached house and the results of those measurements both before and after house tightening (storm doors, storm windows and caulking/weatherstripping). The house, located in Portland, has a fireplace with a forced air blower/exchanger system with a sealed glass door. The fireplace usage was recorded by the occupant during the measurements of air exchange rates. Indoor levels of formaldehyde, CO and particulate matter were also monitored during the measurement of air exchange rate. The author attempts to define any correlations of air exchange rate with wood burning and examines how air exchange rate is affected by the house tightening.

19772 The Bonneville Power Administration's conservation program. Baechler, M.C. (Battelle Pacific Northwest Lab., Portland, OR (US)). pp. 504 of Proceedings of a international conference on residential wood energy. Zhejing University Press, Hangzhou, China (1986). (CONF-860323–: International conference on residential wood energy, Reno, NV (USA), 4-6 Mar 1986).

This paper discusses some of Bonneville Power Administration's (BPA) findings in following the National Environmental Policy Act (NEPA) process as they relate to the agency's policies about woodstove use in energy-efficient homes. BPA divides its programs between the weatherization of existing homes and building new energy-efficient homes. Key points of the interaction between NEPA and BPA's conservation program are described.

19773 Estimating pollutant concentrations and health risks of exposure to indoor air pollutants from wood stoves. Raley, D.L. (Mueller Associates, Inc., Baltimore, MD (USA)); Jacobsen, P.I.; Moses, D.O. pp. 504 of Proceedings of a international conference on residential wood energy. Zhejing University Press, Hangzhou, China (1986). (CONF-860323–: International conference on residential wood energy, Reno, NV (USA), 4-6 Mar 1986).

A graphical procedure is presented for estimating residential indoor pollutant concentrations based on two primary factors, pollutant source strength, and air exchange rate. Methods for incorporating the effect of alternative house volumes and outdoor concentrations are also presented. The results of a sensitivity analysis illustrates the relative importance of the various factors in determining pollutant concentration. The known health effects associated with the range of anticipated indoor pollutant concentrations are described. In addition to estimating pollutant concentrations and potential health effects, options the homeowner has for improving air quality are discussed. The paper presents results from several projects recently conducted for the U.S. Department of Energy.

19774 Thermal bridges in homogeneous walls: a simplified approach. Hassid, Samuel (Lawrence Berkeley Lab., CA (USA)). *Building and Environment (UK)*, 24(3): 259-264 (1989). DOE Contract AC03-76SF00098.

An integral approach is used to derive a simplified expression for heat transfer in thermal bridges between homogeneous walls. The expression makes it possible to evaluate the effect of different parameters, such as width and conductivity of the wall and of the thermal bridge, on the overall heat transfer coefficient and the minimum surface temperature. The expression is found to be in good agreement with numerical calculations based on finite difference discretization. (author).

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Refer also to citation(s) 19270, 19324, 19395, 19468, 19497, 19738, 20212, 20226, 20233, 20251

19775 (AD-A-214181/0/XAB) **Planning minimum-energy paths in an off-road environment with anisotropic traversal costs and motion constraints. Doctoral thesis.** Ross, R.S. Naval Postgraduate School, Monterey, CA (USA). Jun 1989. 280p. (NPS-52-89-040). Available from NTIS, PC A13/MF A02.

For a vehicle operating across arbitrarily-contoured terrain, finding the most fuel-efficient route between two points can be viewed as a high-level global path-planning problem with traversal costs and stability dependent on the direction of travel (anisotropic). The problem assumes a two-dimensional polygonal map of homogeneous cost regions for terrain representation constructed from elevation information. The anisotropic energy cost of vehicle motion has a non-braking component dependent on horizontal distance, a braking component dependent on vertical distance, and a constant path-independent component. The behavior of minimum-energy paths is then proved to be restricted to a small, but optimal set of traversal types. An optimal-path-planning algorithm, using a heuristic search technique, reduces the infinite number of paths between the start and goal points to a finite number by generating sequences of goal-feasible window lists from analyzing the polygonal map and applying pruning criteria. The pruning criteria consist of visibility analysis, heading analysis, and region-boundary constraints. Each goal-feasible window lists specifies an associated convex optimization problem, and the best of all locally-optimal paths through the goal-feasible window lists is the globally-optimal path. These ideas have been implemented in a computer program, with results showing considerably better performance than the exponential average-case behavior predicted.

19776 (CONF-900464-2) **Design of a high power density, permanent magnet, axial gap dc motor.** Hawsey, R.A. (Oak Ridge National Lab., TN (USA)); Daniel, D.S.; Thomas, R.J.; Bailey, J.M. Oak Ridge National Lab., TN (USA). [1990]. 19p. Sponsored by U.S. Department of Defense. DOE Contract AC05-84OR21400. From IEEE Southeastcon; New Orleans, LA (USA); 1-4 Apr 1990. Order Number DE90005449. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In the design of drive motors for undersea vehicles, the premium placed on noise suppression suggests the use of a brush-commutated dc motor. The additional constraints of weight and volume, as well as unusual configuration, presents the axial air-gap configuration, with a permanent magnet field, as a viable candidate. In such a configuration the design of the brushes and commutator and the resulting structure becomes critical. The report describes a novel solution to this problem. The basic motor consists of two discs containing permanent magnets on either side of a magnetic structure containing the copper windings. An advantage of this motor concept is that copper cooling may easily be accomplished through the use of liquid circulating through the stator windings. The role of field and armature in a conventional disc motor configuration are reversed. The two discs containing the permanent magnets are rotating. The brushes are on the discs. The magnetic structure with the coils is stationary. The commutator bars are imbedded in the stationary member. Input power is supplied to the brushes through a brush-and-slip ring assembly. An electromagnetic design analysis for a 92 ft-lb, 700 rpm motor was performed. A finite element analysis has been conducted and the results show that magnetic saturation is not a limiting factor in this design. The motor torque is achievable within weight and volume constraints. 9 figs., 1 tab.

19777 (DOE/ET/32043-T29-Bk.1) **Safety Status Report for the Ulysses mission: Accident analysis (Book 1).** General Electric Co., Philadelphia, PA (USA). Astro Space Div. Jan 1990. 127p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC01-79ET32043. Order Number DE90006829. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

The status of the accident analysis for the Ulysses outer planetary space science mission is presented in this Safety Status Report (SSR). This mission employs a Radioisotope Thermoelectric Generator (RTG) as the prime electrical power source for the spacecraft. Ulysses will be launched into earth orbit using the Space Shuttle and will use the Inertial Upper Stage (IUS)/Payload Assist Module-Special (PAM-S) boosters to place the spacecraft into an earth escape trajectory. The RTG employs silicon-germanium thermoelectric couples to produce electricity from the heat energy that results from the decay of the radioisotope fuel, Plutonium-238, used in the RTG heat source. The heat source configuration used in the RTG is termed General Purpose Heat Source (GPHS), and the RTG is designated GPHS-RTG. The use of radioactive material in these missions necessitates evaluations of the radiological risks that may be encountered by launch complex personnel as well as by the earth's general population resulting from postulated malfunctions or failures occurring in the mission operations. The SSR presents the results of a rigorous safety assessment, including substantial analyses and testing, of the launch and deployment of the RTG for the Ulysses mission. 12 refs., 24 figs., 14 tabs.

19778 (DOE/ET/32043-T29-Bk.2) **Safety Status Report for the Ulysses mission: Accident analysis - Appendices (Book 2).** General Electric Co., Philadelphia, PA (USA). Astro Space Div. Jan 1990. 625p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC01-79ET32043. Order Number DE90006830. Available from NTIS, PC A99/MF A01 - OSTI.

This section of the Accident Analysis presents the appendices which describe the various analyses that have been conducted for use in the Ulysses Safety Status Report. Included in these appendices are the approaches, techniques, conditions and assumptions used in the development of the analytical models plus the detailed results of the analyses. Also included in these appendices are summaries of the accidents and their associated probabilities and environment models taken from the Shuttle Data Book (NSTS-08116), plus summaries of the several segments of the recent GPHS safety test program. The information presented in these appendices is used in Section 3 of Book 1 to develop the Failure/Abort Sequence Trees (FASTs) and to determine the fuel releases (source terms) resulting from the potential Space Shuttle/IUS accidents throughout the missions. 73 refs., 276 figs., 117 tabs.

19779 (ESC-WR-89-22) **Air pollution of trolleybus and dieselbus compared.** Kroon, P. Stichting Energieonderzoek Centrum Nederland, Petten (Netherlands). Energie Studie Centrum. Dec 1989. 11p. (In Dutch). Available from Netherlands Energy Research Foundation ECN, P.O. Box 1, 1755 ZG Petten, Netherlands.

A trolleybus has several advantages and disadvantages compared to a dieselbus. One of the advantages is the low contribution to air pollution. Comparisons of emission data have been made for the present situation and for the future if the measures to be taken according to the Dutch National Environmental Policy (NMP) are realized. It is expected that the relative position of the trolleybus will improve even more. 10 refs., 5 tabs.

19780 (LA-11756-PR) **Space Nuclear Safety Program progress report, October-December 1987.** George, T.G. (comp.). Los Alamos National Lab., NM (USA). Feb 1990. 37p. Sponsored by U.S. DOE Nuclear Energy; U.S. DOE Radioactive Waste Management. DOE Contract W-7405-ENG-36. Order Number DE90006436. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This quarterly report describes studies related to the use of $^{238}PuO_2$ in radioisotope power systems, carried out of the Office of Defense Energy Programs and Special Applications of the US Department of Energy by Los Alamos National Laboratory. The studies discusses are ongoing; the results and conclusions described may change as the work progresses. 24 figs., 12 tabs.

19781 (LA-11777-MS) **Accident Response Group vans: Elastic-plastic analysis of floor plate under acceleration loads.** Lewis, M.W. Los Alamos National Lab., NM (USA). Apr 1990. 46p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. Order Number DE90007688. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Accident Response Group (ARG) at the Los Alamos National Laboratory has established specific design criteria for two vans that will be used to transport personnel and massive equipment across various types of terrain. The vans must be capable of

meeting survivability requirements when subjected to acceleration loads of 10 to 20 g's in different directions. To prove survivability, one must show that the van floor plates, to which the equipment is mounted, maintain integrity under these accelerations. The ABAQUS finite element code was used to simulate the effect of these accelerations, the equipment, and the van frame on each of two floor plates. Various accelerations were simulated in the longitudinal (x), lateral (y), and vertical (z) directions. The analyses showed that the floor plates will withstand accelerations of 20 g's longitudinally and 10 g's laterally and vertically. This report provides details of this analysis and presents my findings and recommendations. 67 figs., 4 tabs.

19782 (LA-UR–89-3858) **Working on the moon: The Apollo experience.** Jones, E.M. Los Alamos National Lab., NM (USA). [1989]. 11p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-900442–3: Engineering, construction and operations for space, Albuquerque, NM (USA), Apr 1990). Order Number DE90003662. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The successful completion of any scientific or engineering project on the Moon will depend, in part, on human ability to do useful work under lunar conditions. In making informed decisions about such things as the use of humans rather than robots for specific tasks, the scheduling of valuable human time, and the design and selection of equipment and tools, good use can be made of the existing experience base. During the six completed landing missions, Apollo lunar surface crews conducted 160 astronaut-hours of extravehicular activities (EVAs) and also spent a similar sum of waking hours working in the cramped confines of the Lunar Module. The first three missions were primarily proof-tests of flight hardware and procedures. The ability to land equipment and consumables was very modest but, despite stay times of no more than 32 hours, the crews of Apollos 11, 12, and 14 were able to test their mobility and their capability of doing useful work outside the spacecraft. For the last three missions, thanks to LM modifications which enabled landings with significant amounts of cargo, stay times more than doubled to three days. The crews were able to use Lunar Rovers to conduct extensive local exploration and to travel up to 10 kilometers away from their immediate landing sites. During these final missions, the astronauts spent enough time doing work of sufficient complexity that their experience should be of use in the formulation early-stage lunar base operating plans. 2 refs.

19783 (LA-UR–90-443) **Low-cost small satellites for astrophysical missions.** Priedhorsky, W.C. Los Alamos National Lab., NM (USA). [1989]. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-891276–4: Workshop on high energy astrophysics in the 21st century, Taos, NM (USA), 10-14 Dec 1989). Order Number DE90007625. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A miniature satellite is a low-cost platform to support a small space experiment. Space astrophysics has been hindered by decades-long delays in important experiments. With miniature satellites, one hopes to reduce both experiment cost and lead time to an affordable level. Miniature satellites are not a new idea. The first scientific satellites, including Explorer I, were small and developed on a timescale of months. Important science was done by these pioneer missions. Though the easy discoveries have been made, important missions in exploration and follow-up can still be carried out from small platforms. Successful small satellite programs continue to this day. These include the OSCAR amateur radio satellite program, in which 12 small satellites, built by amateurs, have been flown over 25 years with no satellite failures (Fleeter, 1988). Two small free-flyers, GLOMAR and NUSAT, were ejected from the Shuttle in 1985. GLOMAR, a radio-relay experiment, was built in less than a year for under $1 million, and operated over a year in orbit. Small satellite projects continue to this day. Approaching launch are the Air Force STACKSAT array of 3 small satellites (P87-2), a number of other small satellites under Department of Defense auspices. The Air Force Space Test Program is developing a standard small experiment platform called STEP (Space Test Experiment Platform). NASA has started a small explorer program, beginning with SAMPEX, a solar and magnetospheric particle explorer, FAST, a fast auroral snapshot experiment, and SWAS, a submillimeter astronomy experiment. 5 refs., 2 figs., 2 tabs.

19784 (NUS–5235-Bk.1) **Safety Status Report for the Ulysses mission: Risk analysis (Book 1).** NUS Corp., Gaithersburg, MD (USA). 31 Jan 1990. 28p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC01-87NE32134. Order Number DE90006826. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The purpose of this report is to provide the most recent results of the analysis of the range of potential consequences of accidents which have been identified during the launching and deployment of the Ulysses mission spacecraft. The specific consequences analyzed are those associated with the possible release of radioactive material (fuel) of the RTG. They are in terms of radiation doses to people and areas of deposition of radioactive material. These consequence analyses can be used in several ways. One way is to identify the potential range of consequences which might have to be dealt with if there were to be an accident with a release of fuel to assure that, given such an accident, the health and safety of the public will be reasonably protected. Another use of the information, along with accident and release probabilities, is to estimate the risks associated with the mission. That is, most space launches occur without incident. Given an accident, the most probable result relative to the RTGs is complete containment of the radioactive material. Only a small fraction of accidents might result in a release of fuel and subsequent radiological consequences. The combination of probability with consequence is risk, which can be compared to other human and societal risks to assure that no undue risks are implied by undertaking the mission. 5 refs., 4 figs., 4 tabs.

19785 (NUS–5235-Bk.2) **Safety status report for the Ulysses mission: Risk analysis (Book 2).** NUS Corp., Gaithersburg, MD (USA). 31 Jan 1990. 177p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC01-87NE32134. Order Number DE90006827. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

This appendix describes the methods used in evaluating the radiological consequences and the integrated mission risks presented in the Safety Status Report (SSR): Risk Analysis (Book 1). 83 refs., 44 figs., 38 tabs.

19786 (NUS–5238) **Safety Status Report for the Ulysses mission: Summary.** NUS Corp., Gaithersburg, MD (USA). 31 Jan 1990. 25p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC01-87NE32134. Order Number DE90006828. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This document is a condensation of the important features of the Ulysses mission Safety Status Report (SSR). The SSR reports the best information available at this time on the accident and risk analysis for the Ulysses mission. These are ongoing analyses of SRB failure accidents which could alter the results. These updated analyses will be documented in the Final Safety Analysis Report, scheduled for completion in March 1990. Meanwhile NASA requires information on mission risks to support its Environmental Impact Statement and the Interagency Nuclear Safety Review Panel can use the SSR as initial input to its review process. The central estimate (base case) results of this interim risk assessment indicate that none of the postulated accidents of the mission would be expected to result in a health effect (fatal cancer). Calculated maximum radiation doses to individuals for the base case releases are low (in the millirem to tens of millirem range). Probabilities of an accident with a release in the launch area are below one in ten million. Therefore launch area risk to individuals is effectively zero. However, there is a potential, in the event of an accident release, of up to 26 km^2 of land area to require evaluation for the necessity of remedial action because of land contamination exceeding an EPA screening level. 4 figs., 4 tabs.

19787 (ORNL/TM–11361) **Computer-assisted flexible routing to increase usage and cost effectiveness of urban and suburban mass-transit bus systems.** Smith, O.L. Oak Ridge National Lab., TN (USA). Jan 1990. 19p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number

DE90006428. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A screening study was performed to assess the feasibility of using computer-aided routing to improve the efficiency and cost effectiveness of mass-transit bus operations. The methodology is intermediate between the conventional fixed route and dial-to-ride concepts. Preliminary technical and economic analyses suggest that significant cost benefits are achievable, depending upon the manner in which the methodology is applied. 6 refs., 5 figs., 5 tabs.

19788 (PNL–7269) **Technology evaluation for space station atmospheric leakage.** Lemon, D.K.; Friesel, M.A.; Griffin, J.W.; Skorpik, J.R.; Shepard, C.L.; Antoniak, Z.I.; Kurtz, R.J. Pacific Northwest Lab., Richland, WA (USA). Feb 1990. 110p. Sponsored by National Aeronautics and Space Administration. DOE Contract AC06-76RL01830. Order Number DE90007844. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

A concern in operation of a space station is leakage of atmosphere through seal points and through the walls as a result of damage from particle (space debris and micrometeoroid) impacts. This report describes a concept for a monitoring system to detect atmosphere leakage and locate the leak point. The concept is based on analysis and testing of two basic methods selected from an initial technology survey of potential approaches. 18 refs., 58 figs., 5 tabs.

19789 (SAND–89-1658C) **Test component attachment effects on resonant plate pyrotechnic shock simulation.** Bell, G.R.; Zimmerman, R.M. Sandia National Labs., Albuquerque, NM (USA). [1989]. 12p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900479–3: 36. Institute of Environmental Science annual technology meeting, New Orleans, LA (USA), 23-27 Apr 1990). Order Number DE90006478. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

An accepted technique for simulating pyrotechnic shock inputs has been the resonant plate test. The plate is designed so that its predominant modes generate the desired frequency content of a given shock test specification. The success of the test is dependent on the engineer's ability to effectively design and control the response of the resonant plate. In designing a test to simulated a pyrotechnic environment, the location and mass of the test item become very important considerations since they have a profound impact on the dynamic response of the resonant plate. A relatively massive test item can change the plates's resonant frequency. Differences in the relative frequencies of the test item's fixture and the resonant plate may also effect the input to the test items. In this study, a simple mock test assembly is used to study test item and resonant plate interactions during a test. The implications of this interaction regarding the deviations of the shock test specification are also discussed. Data from shock tests performed with the test assembly mounted to a rigid mounting surface and a flexible resonant plate are compared. Frequency response functions and shock response spectra are generated from the test data and compared to show the significance of: (1) the relative stiffness of the mounting surface; and (2) the location of the input control point during a resonant plate test. These factors are shown to be particularly important in using resonant plate testing to simulate pyrotechnic shock environments. 5 refs., 7 figs.

19790 (SAND–89-2140C) **Helicopter flight vibration of large transportation containers: A case for testing tailoring.** Rogers, J.D.; Beightol, D.B.; Doggett, J.W. Sandia National Labs., Albuquerque, NM (USA). [1989]. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900479–4: 36. Institute of Environmental Science annual technology meeting, New Orleans, LA (USA), 23-27 Apr 1990). Order Number DE90007429. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A testing situation is described in which the test specification was derived from MIL-STD-810D for helicopter flight vibration of some test items. The items were to be inside two very large transportation containers – masses on the order of 2000 to 4000 pounds. Severe testing difficulties were anticipated in achieving the desired levels from the test specification. It was then decided to obtain appropriate field data to modify the test specification. The data were obtained during flights of CH-47D helicopters containing the transportation containers. The vibration levels experienced by the test items were significantly below those specified in the original test plan.

19791 (WHC-EP–0336) **Motor carrier evaluation program.** Portsmouth, J.H.; Maxwell, J.E.; Boness, G.O. Westinghouse Hanford Co., Richland, WA (USA). Feb 1990. 60p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. Order Number DE90006351. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The purpose of the Motor Carrier Evaluation Program is to develop a set of standards or guidelines that can be used to evaluate the ability of motor carriers to safely transport Highway Route Controlled Quantities (HRCQ) and Truckload (TL) quantities of radioactive and hazardous materials or wastes owned by the US Department of Energy (DOE). This program document consists of a narrative report detailing the criteria and methodology used to objectively evaluate potential motor carriers. A sample Motor Carrier Evaluation/Carrier Profile and a Motor Carrier Inspection Data Sheet are included as appendices to this report. Organizations offering hazardous materials, such as radioactive materials and hazardous chemicals or wastes for transportation, have a regulatory and ethical responsibility to select transporters that are in compliance with all applicable federal, state, and local regulations related to the transportation of these commodities. 8 refs.

19792 (WHC-EP–0337) **Motor carrier evaluation program policy.** Portsmouth, J.H.; Maxwell, J.E.; Boness, G.O. Westinghouse Hanford Co., Richland, WA (USA). Feb 1990. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. Order Number DE90006350. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The US Department of Energy (DOE) Transportation Management Division (DOE-TMD) has the overall responsibility to provide a well managed transportation program for the safe, efficient and economical transportation of DOE owned material. In the performance of these duties the DOE-TMD has established an exemplary safety record in the transportation of hazardous materials. In fulfillment of its responsibility for the safe transportation of radioactive materials as well as other hazardous commodities and wastes routinely shipped from many DOE locations nationwide, DOE-TMD has developed this policy and program for a motor carrier evaluation program. It is the intent of DOE-TMD that this Motor Carrier Evaluation Program be implemented at all DOE locations. This program will assist in the evaluation of carriers transporting Highway Route Control Quantities (HRCQ) of radioactive material, because these shipments frequently are in the "public eye." The program will be expanded at a later date to include Truckload (TL) quantity transporters of radioactive materials and waste. The expansion of the program to include motor carriers other than HRCQ radioactive material transporters would be performed in a gradually phased program over a predetermined period of time. 11 refs.

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Refer also to citation(s) 19463, 19467, 19468, 19513, 19699, 19700, 19826, 20105, 20223, 20289, 20392, 21041

19793 (CONF-900351–1) **Two-stage fluidized-bed/cyclonic agglomerating incinerator.** Rehmat, A.; Lau, F.; Bryan, B.; Goyal, A.; Khinkis, M. Institute of Gas Technology, Chicago, IL (USA). [1990]. 17p. Sponsored by Institute of Gas Technology. From 3. annual presentation: HazMat Central; Rosemont, IL (USA); 13-15 Mar 1990. Available from OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616.

The Institute of Gas Technology (IGT) is developing a two-stage fluidized-bed/cyclonic agglomerating incinerator that combines the fluidized-bed agglomeration/incineration and cyclonic combustion/incineration technologies that have been developed separately at IGT over many years. This combination results in a unique and extremely flexible incinerator for solid, sludge, liquid, and gaseous wastes. This system can operate over a wide range of conditions in the first stage, from low temperature (desorption) to high temperature (agglomeration), including gasification of high-Btu wastes. In the combined system, solid, liquid, and gaseous organic wastes would be easily and efficiently destroyed [>99.99% destruction and

removal efficiency (DRE)], whereas solid inorganic contaminants would be contained within a glassy matrix, rendering them benign and suitable for disposal in an ordinary landfill. This technology is unique and different from other existing technologies because of its agglomeration and encapsulation capability and its flexibility with respect to the types of wastes it can handle. Both the fluidized-bed as well as the cyclonic incineration technologies have been fully developed and tested separately at pilot scales. 9 refs., 4 figs., 4 tabs.

19794 (CONF-900351–2) **Destruction of industrial waste via cyclonic incineration.** Khinkis, M.J. Institute of Gas Technology, Chicago, IL (USA). [1990]. 33p. Sponsored by Institute of Gas Technology. From 3. annual presentation: HazMat Central; Rosemont, IL (USA); 13-15 Mar 1990. Available from OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616.

The incineration of wastes is rapidly becoming an attractive alternative to landfilling and sometimes is the only means available to destroy hazardous wastes. The Institute of Gas Technology (IGT) has been active for several years in the R&D of cyclonic incineration technology described in this paper. The cyclonic incineration system has several advantages over existing methods and provides very high destruction and removal efficiencies (DRE) especially for gaseous and liquid wastes. For some wastes this technology is available for use on a commercial scale. 14 figs., 17 tabs.

19795 (DOE/CH/10093–75) **Separation, fractionation, concentration, and drying of food products: A technical case study.** Solar Energy Research Inst., Golden, CO (USA); Energetics, Inc., Columbia, MD (USA). Dec 1989. 16p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093;AC01-87CE40762. Order Number DE90000305. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Researchers have investigated a new approach that separates juice into pulp and serum (liquid) fractions. The fractions are then processed individually and more efficiently to reduce the water content. Finally, the fractions are recombined at the site of use to obtain conventional or new products. Efforts to date have included laboratory and on-site studies of several fractionation schemes using energy-efficient membrane-based microfiltration, ultrafiltration, and hyperfiltration processes. These processes are used in combination with more conventional separation, concentration, and recombination methods such as centrifugation, vacuum evaporation, and homogenization. This technical case study provides an overview of the entire DOE/NFPA R&D project and highlights the on-site testing of an advanced processing scheme for tomato juice. This scheme involves separation (centrifugation), concentration (hyperfiltration and evaporation), and recombination (homogenization) processes. The document is aimed at making field test and data analysis results available to other researchers and to private industry in a timely manner. The case study discusses project status; summarizes field testing efforts; and reviews potential technology impacts in terms of applications, energy savings, and preliminary economics.

19796 (DOE/ID/10368–1-Vol.1) **A study of industrial waste stream sources for wet oxidation: Volume 1.** Versar, Inc., Springfield, VA (USA). 20 Dec 1989. 104p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AP07-89ID10368. Order Number DE90007195. Available from NTIS, PC A06/MF A01 - OSTI.

This study was undertaken to support the US Department of Energy (DOE), Office of Industrial Programs, in its effort to assist the development and evaluation of the technical and economic viability of a supercritical wet oxidation system for energy recovery from high-organic content industrial wastewaters. The goal of this study was to identify potential candidate industries likely to have aqueous waste streams having characteristics amenable to supercritical wet oxidation for treatment and energy recovery. The focus of this study was to be on major industrial categories, including some for which preliminary assessments had been conducted, e.g., the food and beverage processing, chemical, pharmaceutical, coal processing, and pulp and paper industries. It had already been determined that within some of these industries, there were a number of high-organic content wastewater streams meeting minimum thermal energy levels for which wet oxidation for energy recovery was possible. What was not known was the size of the potential market for wet oxidation. The goal of this study was to determine the number of target opportunities (i.e., to quantify the facilities with waste streams of sufficient thermal energy levels) within major industries in the United States and to estimate the size of the market for promoting commercialization of wet oxidation for energy recovery. 13 refs., 29 tabs.

19797 (DOE/ID/12726–1) **Advanced moisture sensor research and development: Phase 1, Final report.** Nicholls, C. Southwest Research Inst., San Antonio, TX (USA). Instrumentation Research Div. Nov 1989. 67p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FC07-88ID12726. Order Number DE90007359. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This report details the progress in the Phase I, proof of principle study for the DOE sponsored development of an advanced moisture sensor for use in non-paper drying applications. Under this program Southwest Research Institute of San Antonio Texas has developed a novel sensing system based on the technique of hydrogen transient nuclear magnetic resonance (HTNMR). The purpose of the sensor is to improve the efficiency of the drying process. Wide scale application of such efficiency improvements would not only save the consumers money but also reduce the energy consumption, and hence oil imports of the United States. 33 refs., 20 figs., 6 tabs.

19798 (DOE/ID/12795–1) **Energy conservation through recycling of factory asphalt roofing waste.** Shepherd, P.B. (Manville Sales Corp., Denver, CO (USA). Manville Technical Center); Powers, T.J.; Hardy, J.; Maloof, R.; Patenaude, C.; Zilfi, J. Manville Sales Corp., Denver, CO (USA). Manville Technical Center; Bird Roofing, Norwood, MA (USA). 31 Dec 1989. 273p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FC07-88ID12795. Order Number DE90006304. Available from NTIS, PC A13/MF A01 - OSTI.

Prior DOE laboratory research showed that it was possible to recover the energy resource represented in factory shingle waste. This waste could be processed and recycled into the asphalt composition used to make new shingles. This bench-scale research concluded that factory experiments were all that were needed to provide a basis for commercial implementation. The project reported here completed that full scale research. Factory fiber glass shingle waste was processed to a form suitable for recycling. The processed waste was then mixed into the asphalt used to make new shingles. Process parameters and shingle quality were measured to provide a basis for commercial implementation.

19799 (EMR/CANMET–81-25(TR)) **Energy conservation in the foundry industry.** Buhr, R.K. (ed.) Canada Centre for Mineral and Energy Technology, Ottawa, ON (Canada). Apr 1981. 137p. (CONF-8010391–: Energy conservation in the foundry industry, Cambridge (Canada), 30-31 Oct 1980; MICROLOG–89-05075). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $0.34 CAN per page, $3.40 minimum; MF $10 CAN.

Energy conservation is a two-step process (identification and execution) and the execution usually involves capital expenditure. Energy wasting practices are common in founderies. In general, compared with other types of heavy industry, there are relatively few major pieces of equipment in the foundry that require large inputs of energy - by those few items may represent more than 80% of the total plant energy load. This paper describes some general energy conserving methods used by Canron. Areas discussed include: lighting, air compressors, redesign of a blast capola and heat treat ovens, oxygen enrichment to reduce core usage and electrical energy control. Areas where heat can be reclaimed are identified. In several cases, the cost of capital equipment far exceeds any potential savings and cannot be justified.

19800 (EMR/CANMET–81-25(TR)) **Energy conservation in the foundry industry.** Buhr, R.K. (ed.) (Canada Centre for Mineral and Energy Technology, Ottawa, ON (Canada)). Canada Centre for Mineral and Energy Technology, Ottawa, ON (Canada). Apr 1981.

137p. (CONF-8010391–: Energy conservation in the foundry industry, Cambridge (Canada), 30-31 Oct 1980; MICROLOG–89-05075). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $0.34 CAN per page, $3.40 minimum; MF $10 CAN.

The production of castings requires the consumption of considerable quantities of energy. The rapid increase in the price of all forms of energy has therefore had a large impact on the foundry industry. This seminar was planned to bring together a speakers from industry and government and to present a range of information and ideas on energy conservation in the foundry industry. Presentations were oriented to the needs of the operating foundryman. Topics covered included heat recovery, energy conservation, and increased efficiency. Separate abstracts were prepared for 9 papers.

19801 (EMR/CANMET–81-25(TR), pp. 86-111) **How to increase cupola efficiency.** Warda, R.D. (Canadian Centre for Mineral and Energy Technology, Ottawa, ON (Canada)). Canada Centre for Mineral and Energy Technology, Ottawa, ON (Canada). Apr 1981. (CONF-8010391–: Energy conservation in the foundry industry, Cambridge (Canada), 30-31 Oct 1980; MICROLOG–89-05075). In *Energy conservation in the foundry industry.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $0.34 CAN per page, $3.40 minimum; MF $10 CAN.

The melting efficiency of iron foundry cupolas has been the subject of a coast-to-coast survey conducted by CANMET during the past year. This paper provides a summary of this survey. Thirty foundries were selected for testing representing a wide range of size, design, operating practice and metal demand. These data were incorporated later in the body of information gathered during the in-plant tests to provide a comparison between what foundry personnel thought was happening in their cupola and what was actually happening. 22 refs., 5 tabs.

19802 (EMR/CANMET–81-25(TR), pp. 71-85) **Efficient ladle preheating.** Davis, K.G. (Canadian Centre for Mineral and Energy Technology, Ottawa, ON (Canada)). Canada Centre for Mineral and Energy Technology, Ottawa, ON (Canada). Apr 1981. (CONF-8010391–: Energy conservation in the foundry industry, Cambridge (Canada), 30-31 Oct 1980; MICROLOG–89-05075). In *Energy conservation in the foundry industry.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $0.34 CAN per page, $3.40 minimum; MF $10 CAN.

The efficiency of preheating a 1000 lb (450 kg) ladle by a natural gas torch was examined with respect to torch-head position, ladle configuration, lining material and thickness, and the use of ladle covers. The highest preheat temperatures in an open ladle with the torch-head near the centre of the ladle mouth, approximately level with the rim have been obtained. There was no advantage in having the ladle on its side or inverted, compared with the normal, upright position. A fireclay-mullite refractory lining reached a higher temperature after a given preheat than did a high-alumina lining. With an insulating cover, a 50% saving of gas required to reach a given lining temperature was realized. 15 figs

19803 (EMR/CANMET–81-25(TR), pp. 53-70) **Energy use in the Canadian foundry industry.** James, B. (Energy, Mines and Resources Canada, Ottawa, ON (Canada)). Canada Centre for Mineral and Energy Technology, Ottawa, ON (Canada). Apr 1981. (CONF-8010391–: Energy conservation in the foundry industry, Cambridge (Canada), 30-31 Oct 1980; MICROLOG–89-05075). In *Energy conservation in the foundry industry.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $0.34 CAN per page, $3.40 minimum; MF $10 CAN.

This paper presents the energy use patterns of the industry in terms of the primary energy input types, the quality and form of the energy actually required by the various production processes, and the residual form of this energy, either embodied in the product or rejected in gaseous and liquid waste heat streams. The opportunities and advantages of implementing energy-saving measures to improve the efficiency of energy use are related to the changing role of energy since the 1973 oil crisis. It appears that energy will be an increasing concern for the industry during the 1980s. Energy savings will lead directly to increased profit for the foundry industry. These savings will also provide a highly cost-efficient contribution to the overall national energy strategy. 4 figs. 7 tabs.

19804 (EMR/CANMET–81-25(TR), pp. 9-12) **Heat recovery.** Robinson, B.W. (Ontario Hydro, ON (Canada)). Canada Centre for Mineral and Energy Technology, Ottawa, ON (Canada). Apr 1981. (CONF-8010391–: Energy conservation in the foundry industry, Cambridge (Canada), 30-31 Oct 1980; MICROLOG–89-05075). In *Energy conservation in the foundry industry.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $0.34 CAN per page, $3.40 minimum; MF $10 CAN.

Basic metal industries, such as foundries, forge shops, heat treaters, steel mills should be able to minimize space heating costs by using energy from the BTU-ich exhausts. Heat-exchange and heat-storage technology is so advanced that many plants should be able to completely elimate the use of fuel for space heating. Even low-temperature exhaust readings of a few degrees above ambient temperature may be significant if the volume is great. Exhausts carrying from 5000 to 5,000,000 BTU or more have been found. A major source of waste energy are the hot products of combustion currently discarded by most fuel burning industrial processes. These hot combustion products typically contain anywhere from 40% to 90% of the energy initially put into the process. As much as 80% of this wasted heat can be recovered and re-used in the combustion process to reduce fuel consumption by 25% or more. 33 figs.

19805 (EMR/CANMET–81-25(TR), pp. 1-8) **Energy requirements in the foundry.** Buhr, R.K. (Canada Centre for Mineral and Energy Technology, Ottawa, ON (Canada)). Canada Centre for Mineral and Energy Technology, Ottawa, ON (Canada). Apr 1981. (CONF-8010391–: Energy conservation in the foundry industry, Cambridge (Canada), 30-31 Oct 1980; MICROLOG–89-05075). In *Energy conservation in the foundry industry.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $0.34 CAN per page, $3.40 minimum; MF $10 CAN.

The trend towards lighter weight metals in the transportation area is explained from an energy point of view. A brief analysis of the energy distribution in the production of castings is used to demonstrate areas where research has the greatest potential. This is supported by providing some examples of the areas of current research. The main consumer of energy in the foundry is the melting operation; anything that can be done to reduce this energy consumption is beneficial. One such method is to increase the yield. At 50% yield, it requires 2 tons of metal to be melted to produce 1 ton of castings. A significant savings in energy can be realized if that yield could be increased to 60%. Increasing yield can be accomplished by three methods. The first is to reduce the gating and risering requirements, the second is to reduce scrap, and the third method is to convert to one form or another of permanent mould casting wherever possible. The yield from these processes is usually much better than from sand casting. In low-pressure casting, yields as high as 95% have been reported, representing a significant reduction in energy requirements per unit of castings produced. 1 figs., 5 tabs.

19806 (EMR/CANMET–81-25(TR), pp. 112-119) **A review of foundry energy conservation at GM of Canada.** Braithwaite, D. (GM of Canada (Canada)). Canada Centre for Mineral and Energy Technology, Ottawa, ON (Canada). Apr 1981. (CONF-8010391–: Energy conservation in the foundry industry, Cambridge (Canada), 30-31 Oct 1980; MICROLOG–89-05075). In *Energy conservation in the foundry industry.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $0.34 CAN per page, $3.40 minimum; MF $10 CAN.

General Motors of Canada operates an automatic foundry producing very high volumes of grey and modular iron castings by automated methods. Poured tonnage can exceed 3,000 tons per day, of which about 2/3 is grey iron. The formal serge conservation programme started in 1974 after the first oil embargo and has shown a 22% energy use reduction to the end of 1979. An overview was provided of energy cost saving activities at GM of

Canada's metal casting plant in St. Catherines, Ontario. The activities selected differ greatly in their degree of technical sophistication and in the capital required for implementation. Energy conservation projects can cover the full range of levels of sophistication, capital expenditure, operating cost and return on investment. 8 figs., 5 tabs.

19807 (HAZ–CE02855, pp. 304-327) **Organic waste treatment by fluid extraction.** Bromley, D.B. (David Bromley Engineering Ltd., Edmonton, AB (Canada)); Selann, J.; Kaupp, D. Haztech Canada, Edmonton, AB (Canada). 1988. (CONF-8810478–: Haztech western Canada: hazardous waste management and environmental control conference, Edmonton (Canada), 5-6 Oct 1988; CE–02855). In *Haztech Western Canada '88: Hazardous waste management and environmental control conference proceedings.* Available from Haztech Canada, 4936-87th St., no. 26, Edmonton, AB, CAN T6E 5W3. Prices: $50.00 CAN.

There is a strong economic incentive to reduce sludge volumes when one considers the cost of waste handling. This paper addresses some of the problems with the dewatering of organic sludges, as well as some of the common and innovative methods now being developed. The criteria for sludge characterization are listed; the understanding of the relationship between free water and bound water is an important consideration in selecting suitable dewatering techniques, as well as it expresses the efficiency of various sludge conditioning techniques. The development of polyelectrolytes, or polymeric, flocculents was a major advance in sludge conditioning. The paper presents the types of organic sludges (pulp and paper sludge, drilling muds, and petrochemical sludges) and the relevant dewatering methods (mechanical: plate and frame filter press, belt filter press, centrifuges, and diatomaceous earth filters; natural: settling ponds, sludge drying beds, vegetation, and freezing/thawing). The methods are briefly compared. The optimum approach, from the points of view of efficiency, safety and cost, is to develop on off-site facility, which should concentrate on enhanced and controlled natural dewatering techniques; a project to build such a facility in Alberta is evoked. 5 refs., 6 figs.

19808 (HAZ–CE02857) **Haztech Canada Toronto '89: Environmental control/hazardous waste management conference proceedings.** Haztech Canada, Edmonton, AB (Canada). 1989. 494p. (CONF-8905280–: Haztech Canada Toronto '89: environmental control/hazardous waste management conference, Mississauga (Canada), 16-18 May 1989; CE–02857). Available from Haztech Canada, 4936-87th St., no. 26, Edmonton, AB, CAN T6E 5W3. Prices: $50.00 CAN.

This volume concerns the transport and storage of hazardous wastes, the clean-up of hazardous material spills (including biodegradation), the investigation of hazardous waste sites, the chemical analysis of hazardous substances, the decommissioning of industrial plants, and toxicology. It also discusses the low-level radioactive waste program of Atomic Energy of Canada Limited, the appropriate response to emergency situations, and the informing of the public. Separea abstracts have been prepared for 4 papers from this conference.

19809 (IE-MOA–88/0100, pp. 39) **Solar assisted heat pump for greenhouse heating in a typical Mediterranean climate.** Kyritsis, S.; Mavrogiannopoulos, G.; Soldatos, P.; Moshovitis, P. Agricultural Research Organization, Bet Dagan (Israel). Inst. of Agricultural Engineering. Feb 1988. (CONF-8712157–: French Israeli symposium on greenhouse technology, Shefayim (Israel), 7 Dec 1987). In *Report of the French Israeli symposium on greenhouse technology.* Available from COSTI P.O.B 20125, TEL-AVIV 61201.

Order with complete bibliographic information; Abstract only.

A solar assisted heat pump was installed in a 1000 m^2 plastic covered greenhouse to maintain optimum temperature for vegetable production. This installation is in Naxos, one of the Cyclades islands in the middle of Aegean sea. The climatic conditions of Naxos are characterized by very extended sunshine periods, moderate winter temperature without frosts and a relatively cool summer period. The heat pump during the day absorbs heat directly from the sun and the outside air and stores it in a water tank. During the night the stored heat is delivered to the greenhouse by the water-to-air heat exchanger covering about 90% of the greenhouse needs. At peak demand the heat pump supplies heat, functioning like an air-to-air system in parallel with the water-to-air heat exchanger. Total investment cost is $18,000. The system requires electrical energy input of about 25,000 kWh/year. Current oil prices are prohibiting the economic viability of the heat pump. Economic analysis of the system has shown the conditions under which net benefits are high enough to justify this installation. (author)

19810 (ORNL/FTR–3524) **[Transfer of heat pump technology]: Foreign trip report, January 27–February 3, 1990.** Broders, M.A. Oak Ridge National Lab., TN (USA). 23 Feb 1990. 12p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. Order Number DE90007373. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler participated in the activities of the first meeting of the IEA Heat Pump Center National Team Working Group. The meeting provided a forum for National Team representatives from seven participating countries to share information about their respective National Team organization, activities and priorities; and the status of heat pumps in their countries. Particular attention was given to discussion of topics and content of future IEA-HPC Newsletters, analysis studies and workshops. In-depth, follow-up discussions of US National Team activities with both the IEA-HPC and IEA-CADDET were held with staff personnel at the operating agent Netherlands Agency for Energy and the Environment (NOVEM) headquarters in Sittard, The Netherlands.

19811 (PB–90-127366/XAB) **Generalized methodology for conducting industrial Toxicity Reduction Evaluations (TRES).** Fava, J.A.; Lindsay, D.; Clement, W.H.; Clark, R.; DeGraeve, G.M. Battelle Columbus Div., OH (USA). Apr 1989. 110p. Available from NTIS, PC A06/MF A01.

The U.S. Environmental Protection Agency or state regulatory agencies, under the Clean Water Act, can require industries which cannot achieve water-quality based effluent limitations specified in their NPDES permit to conduct a Toxicity Reduction Evaluation (TRE). The objective of the TRE is to determine those actions necessary to reduce the effluent's toxicity to acceptable levels. This approach was written to describe a generalized methodology for the design and performance of a TRE at an industrial facility. A six-tier approach was directed toward the reduction of toxicity of the whole effluent rather than specific components within the effluent. A flow chart was designed as a dichotomous key linking the phases in a systematic progression to achieve the final result, which is an effluent that consistently meets the toxicity limitation assigned to it.

19812 (PB–90-127473/XAB) **Immobilization technology seminar: Speaker-slide copies and supporting information.** Wiles, C.; Barth, E. Environmental Protection Agency, Cincinnati, OH (USA). Center for Environmental Research Information. Oct 1989. 183p. (CERI–89-222). Available from NTIS, PC A09/MF A01.

Also available from Supt. of Docs.

Solidification/stabilization technology is being utilized as a treatment technology for Resource Conservation and Recovery Act RCRA listed waste and waste from uncontrolled hazardous waste sites. Several Best Demonstrated Available Technology (BDAT) levels for Resource Conservation and Recovery Act (RCRA) waste codes are based on solidification/stabilization technology. Vitrification technology is emerging as an alternative technology for hazardous waste. Approximately 25% of the Records of Decision (RODs) for Fiscal Year 1988 for the Superfund Program involved solidification/stabilization.

19813 (PB–90-129008/XAB) **Health-hazard evaluation report HETA 88-328-1961, United States Army Corps of Engineers, Arlington, Virginia.** Fleeger, A.K. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). 1989. 21p. (HETA–88-328-1961). Available from NTIS, PC A03/MF A01.

A study was made of possible hazardous working conditions at Fort Myer, Fort McNair, and Cameron Station, located in the Washington, D.C. area. These three sites each had polychlorinated biphenyl (PCB)-containing transformers. Maintenance workers visually inspected these transformers for leakage and manually felt around the gauges and valves for leaking oil. The employees did

not repair the leaks, only report them to the supervisor. No detectable PCBs were noted in seven personal breathing zone samples. Area air samples for PCBs ranged in concentration from not detectable to 4.8 micrograms/cubic meter (microg/m3). Surface wipe samples ranged from not detectable to heavy contamination levels. Many of the transformers were leaking material suspected as containing PCBs. The report concludes that, although breathing-zone samples did not contain detectable concentrations of PCB, there was a potential for exposure to PCB-contaminated surfaces. Specific recommendations are made for clean-up and periodic monitoring.

19814 (PB–90-129016/XAB) **Health-hazard evaluation report HETA 87-121-1968, Riley Brothers, Inc., Burlington, Iowa.** Gupta, S.; Kramkowski, R.; Salisbury, S. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). 1989. 18p. (HETA–87-121-1968). Available from NTIS, PC A03/MF A01.

A study was made of possible hazardous working conditions at Riley Brothers, Inc., Burlington, Iowa. Concern centered around the possibility that certain production workers were exposed to various solvents and that the solvent levels measured in their blood tests were quite varied in nature. The company manufactured paint for different uses according to customer specifications. Major products included formulations of solvent-based paints, and spray painting or dip painting of metal parts. Waterproofing material composed of coal-tar pitch was also made here for use by roofers. One paint formulator had a combined exposure to naphtha and xylene that was 1.7 times the recommended exposure limit. Short term exposures to xylene for two paint strippers were 157 and 173 parts per million (ppm) which exceeded the 150 ppm recommended level. Urinary methyl-hippuric-acid concentrations before and after work shifts indicated a cross shift change greater than 1500 milligrams/gram creatinine which corresponded to an air level of xylene exceeding 100 ppm. Some workers are at risk of developing adverse health effects. Improvements in the ventilation system, use of organic vapor respirators, and use of proper respiratory protection during specified projects are recommended.

19815 (PB–90-129354/XAB) **Predicting bioaccumulation: Development of a simple partitioning model for use as a screening tool for regulating ocean disposal of wastes.** Lake, J.A.; Rubinstein, N.; Pavignano, S. Environmental Protection Agency, Narragansett, RI (USA). Environmental Research Lab. 1987. 19p. (EPA–600/D-89/253). Available from NTIS, PC A03/MF A01.

Pub. in Aquatic Systems, Chapter 12, 151-166(1987).

Simple bioconcentration models and relatively complex food chain models have been used to predict the accumulation of resistant organic compounds in aquatic organisms. Other models based on fugacities have been used to estimate distributions of compounds in idealized environments including organisms. Selection of a model depends on the availability of input data and the objectives of the study. The accuracy of the model prediction, however, depends upon (1) the accuracy of the input variables; (2) the validity of the model for predicting the modeled process; and (3) limitations in the range of applicability of the model including, for environmental studies, the importance of the process that is modeled in determining the total bioaccumulation in the organism.

19816 (PB–90-854415/XAB) **Recycling plastics and polymeric wastes. October 1976-November 1989 (Citations from the COMPENDEX data base). Report for October 1976-November 1989.** National Technical Information Service, Springfield, VA (USA). Dec 1989. 146p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning the recycling and uses of plastic and polymeric scraps and wastes. Topics include communition or grinding of scrap, degradation by heat or chemical reaction, compatibility of various plastics with one another, sorting problems, physical properties of reprocessed materials, economics, public awareness, waste minimization, waste re-use, and foreign experience in plastics recycling. New products made from recycled materials, and products expressly made to be recyclable are also discussed. (Contains 347 citations fully indexed and including a title list.)

19817 (PB–90-854597/XAB) **Energy conservation: Industry. February 1983-December 1989 (Citations from the NTIS data base). Report for February 1983-December 1989.** National Technical Information Service, Springfield, VA (USA). Dec 1989. 173p. Available from NTISPC N01/MF N01.

Supersedes PB–88-853502.

This bibliography contains citations concerning techniques and equipment, and program overviews regarding industrial energy-conservation measures. Topics include case histories and energy audits in a variety of industries, financial and investment aspects, and descriptions of specific energy-conservation projects undertaken in the United States and abroad. The food, metals, pulp and paper, wood, and textile industries are among the industries discussed. (This updated bibliography contains 348 citations, 175 of which are new entries to the previous edition.)

19818 (PB–90-855065/XAB) **Waste recycling in the textile industry. July 1983-September 1989 (Citations from World Textile abstracts). Report for July 1983-September 1989.** National Technical Information Service, Springfield, VA (USA). Dec 1989. 98p. Available from NTISPC N01/MF N01.

This bibliography contains citations on the recycling of waste-fibrous materials for textile production, and the recycling of textile-waste materials. Topics include use of wastes as raw materials for textile and fabric manufacturing; reuse of waste cloth, scraps, fibers, and polymeric materials from textile manufacturing; and the equipment used to collect, sort, and process textile wastes. Materials considered include cellulosic wastes, polymeric wastes, cloth scraps, fiber waste, glass-fiber wastes, and waste dusts. Applications discussed include textile products, insulation, paneling and other building supplies, yarns, roping, and pavement materials. Heat recovery and effluent treatment in the textile industry are referenced in related published bibliographies. (Contains 242 citations fully indexed and including a title list.)

19819 (PB–90-855495/XAB) **Effluent treatment in the textile industry: Excluding dyes. July 1983-September 1989 (Citations from World Textile Abstracts). Report for July 1983-September 1989.** National Technical Information Service, Springfield, VA (USA). Dec 1989. 116p. Available from NTISPC N01/MF N01.

Supersedes PB–89-855266.

This bibliography contains citations concerning the treatment and reuse of textile industry effluents. Effluents that contain dyes are discussed in a separate bibliography. Recovery of lubricants, lye, sizing agents, polyvinyl alcohol, zinc, dirt, and heat from textile effluents are discussed. Air and water pollution control technology that is effective in treating textile effluents is discussed. Effluents from synthetic fiber manufacture and wool scouring processes are emphasized. (This updated bibliography contains 322 citations, 22 of which are new entries to the previous edition.)

19820 (PNL–7202) **Follow-up process evaluation of Bonneville Power Administration's energy savings plan program: Letter report.** Jennings, J.G. (ERC International, Albuquerque, NM (USA)); Peters, J.S. Pacific Northwest Lab., Richland, WA (USA); ERC Environmental and Energy Services Co., Albuquerque, NM (USA). Jan 1990. 65p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC06-76RL01830. Order Number DE90006978. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The Energy $avings Plan (E$P) program has been operated by the Bonneville Power Administration (Bonneville) since late fall 1987. The program is designed to build capability in the acquisition of conservation resources in the non-aluminum industrial sector in the Pacific Northwest. According to the Northwest Power Planning Council, the non-aluminum industrial sector accounts for about 23% of the total regional electricity consumption. Five non-aluminum industries consume 85% of this total. Three major industries — chemical producers, pulp and paper plants, and lumber mills — account for around 68% of non-aluminum industrial consumption (i.e., 16% of the total regional electricity consumption). 1 ref.

19821 (VTT-SYMP–103) **Non-waste technology: Volume 2.** Korhonen, M. (ed.). Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). 1989. 354p. (CONF-8806445–Vol.2: Seminar on non-waste technology, Espoo (Finland), 20-23 Jun 1988). Order

Number DE90748455. Available from NTIS (US Sales Only), PC A16/MF A01.

The VTT Symposium on Non-Waste Technology was held in Espoo, Finland, on June 20-23, 1988. The Symposium was organized within the framework of a three-year research programme on Non-Waste Technology carried out at the Technical Research Centre of Finland in 1986-1988 in the hope of enhancing the interaction between scientists working in different fields of technology and of discussing new possibilities to overcome the difficulties we are facing today and can foresee for tomorrow. The programme consisted of sessions addressing questions of a more general concern and of a series of more detailed technical sessions on Resource Management, Novel Process Technology, Industrial Implementation of Non-Waste Technologies, and Waste Reduction and Pollution Control. The Proceedings cover the technical part of the conference. Poster presentations and workshops were also held to provide a forum for discussions on specific research or industrial activities as well as on the situation in the developing countries.

19822 (VTT-SYMP–103, pp. 187-196) **Methods for treatment of solid wastes and the non-waste technologies.** Daveheva-Heheva, N. (Bulgarian Academy of Sciences, Sofia (Bulgaria) Scientific Coordination Centre for Ecology and Environmental Protection). Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). 1989. (CONF-8806445–Vol.2: Seminar on non-waste technology, Espoo (Finland), 20-23 Jun 1988). In *Non-waste technology: Volume 2.* Order Number DE90748455. Available from NTIS (US Sales Only), PC A16/MF A01.

The paper reviews methods and processes for environmental protection and treatment of solid industrial wastes and natural raw materials. The respective fields of their application, the problems which they solve, as weell as the principles, laws and standards which they follow are determined. On the basis of the existing achievements, the trends in their development and a symptomatic analysis, a classification has been developed and proposed for these methods and processes for environmental protection.

19823 (VTT-SYMP–103, pp. 225-231) **Energy production by anaerobic digestion of waste sludges from the wood processing industry.** Vilppunen, P. (University of Oulu, Oulu (Finland). Energy laboratory); Puhakka, J.; Harmaa, K.; Alavakeri, T. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). 1989. (CONF-8806445–Vol.2: Seminar on non-waste technology, Espoo (Finland), 20-23 Jun 1988). In *Non-waste technology: Volume 2.* Order Number DE90748455. Available from NTIS (US Sales Only), PC A16/MF A01.

The Finnish pulp and paper industry generates about 223 000 tons primary sludge solids and approximately 19 800 tons biological sludge solids per year. The amount of chemical sludge is 13 000 tons as dry solids. The total amount of sludge is estimated to be 348 000 tons of dry solids in 1990. Anaerobic treatment of pulp and paper mill sludge was studied at the Tampere University of Technology and University of Oulu. The first pilot reactor was located at a mill, producing bleached kraft pulp, and the other one at a papermill. The sludge studied was waste activated sludge from the biological waste water process. The volumes of pilot plants are 2.5 and 3.0 m^3. The reactors have mixing equipment, recirculation pumps and the operate automatically. The gas production with the paper mill biological sludge was 0.50 m^3/kg TS-added at the starting period (with a low load). Anaerobic treatment of fiber sediments, deinking and biological sludge was studied in Sweden. The gas production rates were 0.48 m^3/kg VSS for sediments, and the deinking sludge produced 0.28 m^3/kg VSS and the biological sludge 0.25 m^3/kg VSS-added (VSS=volatile suspended solids). In Finland it would be possible to produce about 8 million m^3 biogas from waste sludges of the forest industry, which equal to 4.7 million 1/oil or 48 GWh/heat a year. The VSS reduction by anaerobic treatment was approx. 30%. In order to gain a higher reduction and less sludge to be dewatered, the sludge has to be pretreated by biological, physical or chemical methods. The sludge may be treated aerobically before anaerobic treatment in order to break down the long chain polymers. The anaerobic treatment may decompose some of the organic chlorine compounds formed in bleaching processes. How does this happen is still unknown, and should be studied further.

19824 (VTT-SYMP–103, pp. 217-244) **Integration of biosludge treatment to a pulp process.** Johansson, A. (Technical Research Centre of Finland, Espoo (Finland). Laboratory of Fuel Processing and Lubrication Technology); Raitio, L.; Kylloenen, H.; Thun, R. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). 1989. (CONF-8806445–Vol.2: Seminar on non-waste technology, Espoo (Finland), 20-23 Jun 1988). In *Non-waste technology: Volume 2.* Order Number DE90748455. Available from NTIS (US Sales Only), PC A16/MF A01.

New process alternatives for the treatment of activated sludges from the wood pulping industry are studied by the Technical Centre of Finland (VTT), in co-operation with A. Ahlstrom Corporation. The aim of the research is to develop sludge treatment processes that will meet the requirements of Low- or Non-Waste Technologies: optimal beneficiation of raw materials, saving of energy, internal recycling of process streams, and minimization of waste generation. One such innovative approach, under development, is the integration of sludge treatment with black liquor evaporation in kraft pulping. This non-waste process concept makes the recycling of waste water and an improved utilization of the energy content of biosludges possible at lower costs of sludge treatment and simultaneously reduces the need of extra capital investment in costly filter-belt presses. The new process alternative utilizes surface-active agents present in crude soap for reducing the attraction between sludge particles and water. By adding a small fraction of soap, easily separable from the black liquor and by adjusting pH and temperature, it has been found that the bound water separates spontaneously from the colloidic sludge particles. Thus the dry matter content of the dilute sludge, which admittedly is difficult to dewater, can be raised to 10-15% d.s., by decantation only. The thickened sludge can be added to weak black liquor without significantly increasing the load on the evaporators. The soap fraction, used as dewatering chemical, is separated and recycled, and the decanted water is pumped back to pulp washing. Problems due to fouling of heat exchange surfaces and to lower viscosities are being studied. The latest results and findings are discussed.

19825 (VTT-SYMP–103, pp. 265-272) **A new process for producing a valuable fertilizer from flue gas desulphurization.** Laakso, J. (Rauma Repola Oy, Pori (Finland)); Sarkkinen, V. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). 1989. (CONF-8806445–Vol.2: Seminar on non-waste technology, Espoo (Finland), 20-23 Jun 1988). In *Non-waste technology: Volume 2.* Order Number DE90748455. Available from NTIS (US Sales Only), PC A16/MF A01.

A new sulphur and nitrogen oxide recovery process for stack gases is discussed. The process is based on a method where SO_2 and NO_x are washed by K_2SO_3 solution. After recycling part of SO_2 for regeneration of K_2SO_3, the rest of K_2SO_3 is oxidized to K_2SO_4, a valuable fertilizer. Some KNO_3 is also recovered as a valuable byproduct. The K_2SO_3 washing solution is made from KCl by the process described below. The chemistry and economic aspects of the process are also discussed.

3206 Municipalities and Community Systems

Refer also to citation(s) 19466, 19566, 19748, 19808

19826 (CONF-880673–1) **Incineration R&D with near-term potential.** Khinkis, M.J.; Patel, J.G. Institute of Gas Technology, Chicago, IL (USA). [1988]. 33p. Sponsored by Institute of Gas Technology. From Hazardous waste management for the oil, gas, and chemicals industries; Chicago, IL (USA); 6-8 Jun 1988. Available from OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616.

The incineration of wastes is rapidly becoming an attractive alternative to landfilling and sometimes is the only means available to destroy hazardous wastes. IGT has been active for several years in the R&D of new incineration technologies described in this paper. One innovative technology is a cyclonic incineration system that has several advantages over existing methods and has very high destruction efficiencies especially for gaseous and liquid wastes. Another technique that has been developed is a sloped-grid fluidized-bed incinerator that is ideally suited for the incineration of particulate solids contaminated with hazardous

wastes. IGT has also demonstrated technology for natural gas reburning to reduce NO_x emissions from MSW incinerators. All these technologies have been tested and are available for use on a commercial scale. 25 figs., 29 tabs.

19827 (CONF-890422–4) **Pilot-scale assessment of natural gas reburning technology for NO_x reduction from MSW [municipal solid waste] combustion systems.** Abbasi, H.A. (Institute of Gas Technology, Chicago, IL (USA)); Khinkis, M.J.; Itse, D.C.; Penterson, C.A.; Wakamura, Yasujiro; Linz, D.G. Institute of Gas Technology, Chicago, IL (USA). [1989]. 29p. Sponsored by Institute of Gas Technology. From International conference on municipal waste combustion; Hollywood, FL (USA); 11-14 Apr 1989. Available from OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616.

A program is under way to evaluate the use of natural gas as an NO_x control technique for municipal solid waste (MSW) combustion systems. The program is funded jointly by the Institute of Gas Technology (IGT) Sustaining Membership Program (SMP), the Gas Research Institute (GRI), and Riley Stoker Corporation (Riley) and is a cooperative development effort between IGT, Riley, and Takuma Company, Ltd. (Takuma). The program entails assessment of applicable NO_x control technologies and acquisition of baseline data from a modern existing MSW mass burn facility, followed by pilot-scale development of the selected NO_x control techniques and preparation of design specifications for field verification of this technology. This paper concentrates on the results of the pilot-scale developmental efforts. 6 refs., 13 figs., 5 tabs.

19828 (CONF-891111–2) **An integrated system approach to gas distribution automation.** Rush, W.F.; Huebler, J.E. Institute of Gas Technology, Chicago, IL (USA). [1989]. 11p. Sponsored by Institute of Gas Technology. From International gas research conference; Tokyo (Japan); 6-9 Nov 1989. Available from OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616.

Results of a 4 year program have demonstrated the technical feasibility of a total system approach to automating utility distribution operations. The key concepts of this approach include: treating the entire distribution system as a single system; constructing the system of mutually compatible modules; exploiting inherent system efficiencies to reduce cost and increase capabilities; and preserving options for future developments. Treating distribution operations as a single system reduces automation cost by combining several functions into a single unit, rather than installing separate systems. Modular unit design provides a utility with two benefits. First, it can tailor its system to meet specific needs, such as telephone communication in one part of its system and the use of radio communication in another portion. Second, the utility can add capabilities as desired at a later time. Integrated system design permits inclusion of many capabilities at little or no additional cost. Designing the electronics to accept pulse, analog, and digital inputs permits expansion of the system to incorporate a wide range of technical advances. 2 figs.

19829 (Juel–2309) **Investigations of the volatilization of heavy metals during the combustion of waste with oxygen.** Rachwalsky, U. Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Chemische Technologie der Nuklearen Entsorgung; Technische Hochschule Aachen (Germany, F.R.). Sep 1989. 93p. (In German). Order Number DE90753524. Available from NTIS (US Sales Only), PC A05/MF A01.

Conventional incineration processes for waste treatment produce residues which are difficult to eliminate in an environmentally neutral manner due to their high heavy-metal content. The use of oxygen instead of air for high-temperature refuse incineration as well as a molton slag and filter dust recycling into the furnace will improve the situation with regard to residues. In a laboratory facility samples of waste were incinerated with oxygen. This study examined the volatilization of four environmentally relevant heavy metals (Zn, Cu, Pb, Cd) and their behaviour in an off-gas purification facility. The samples of waste were filter dust from the electrostatic precipitator of a domestic refuse incinerator, synthetic refuse mixed with different heavy-metal compounds (oxides, organometallic compounds, metals, chlorides) and sewage sludge from a municipal sewage treatment plant. Filter dust melting reduced the volatility of heavy metals Cu, Pb and Cd with increasing temperature. Complete separation of volatile heavy metals due to water condensing in the waste gas was prevented by aerosol formation. Synthetic refuse incineration with oxygen showed pronounced differences in volatility for the individual compounds. Experiments with sewage sludge furnished qualitative proof of the volatilization of zinc, copper and lead during combustion in the presence of oxygen. (orig.).

19830 (VTT-SYMP–103, pp. 361) **Energy economic utilization of municipal waste.** Vilppunen, P. (University of Oulu, Oulu (Finland). Energy Laboratory). Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). 1989. (CONF-8806445–Vol.2: Seminar on non-waste technology, Espoo (Finland), 20-23 Jun 1988). In *Non-waste technology: Volume 2.* Order Number DE90748455. Available from NTIS (US Sales Only), PC A16/MF A01.

Abstract only. MUNICIPAL WASTES/waste product utilization; WASTE PRODUCT UTILIZATION/research programs; SOLID WASTES; FINLAND; REFUSE DERIVED FUELS; GASIFICATION; ANAEROBIC DIGESTION; COMBUSTION; ECONOMICS

19831 **Municipal waste processing apparatus.** Mayberry, J.L. To Dept. of Energy, Washington, DC. USA Patent 4,867,866. 19 Sep 1989. Filed date 13 Apr 1988. USA Patent Application 7 180,879. Int. Cl. B07B 9/02. 6p. Available from Patent and Trademark Office, Box 9, Washington, DC 20232.

This patent describes municipal waste materials processed by crushing the materials so that pieces of noncombustible material are smaller than a selected size and pieces of combustible material are larger than the selected size. The crushed materials are placed on a vibrating mesh screen conveyor belt having openings which pass the smaller, noncombustible pieces of material, but do not pass the larger, combustible pieces of material. Consecutive conveyors may be connected by an intermediate vibratory plate. An air knife can be used to further separate materials based on weight.

33 ADVANCED PROPULSION SYSTEMS

3301 Internal Combustion Engines

Refer also to citation(s) 19712, 19838, 20085, 20102

19832 (AD-A–214309/7/XAB) **AGARD (Advisory Group for Aerospace Research and Development)/SMP review. Damage tolerance for engine structures. 2. Defects and quantitative materials behavior.** Advisory Group for Aerospace Research and Development (AGARD), 92 - Neuilly-sur-Seine (France). c Oct 1988. 105p. (AGARD-R–769). Available from NTIS, PC A06/MF A01.

See also report dated Nov 88, AD-A203-451.

Most current military and all civil engines are operated under safe life procedures for their critical components. Experience has shown that this philosophy presents two drawbacks: The move towards designs allowing higher operational stresses, and the use of advanced high-strength alloy make it likely that a disc burst could happen (following a rapid crack growth) well before the statistically-based safe life has been achieved. It is potentially wasteful of expensive components, since it has been estimated that over 80% of engines discs have ten or more low-cycle fatigue lives remaining when discarded under safe life rules. Damage tolerance begins an alternative life being philosophy, the Sub-Committee on Damage Tolerance Concepts for the Design of Engine Constituents has therefore decided to conduct a series of four Workshops addressing the areas critical to damage tolerance design of engine parts. The present report includes the papers presented during Workshop II dealing with Defects and Quantitative Materials Behaviour. It also includes the content of the discussions which followed the presentations.

19833 (DOE/MC/23256–2787-Vol.2) **Development and use of an advanced coal-fueled diesel engine cycle simulation with group effects: Volume 2, Appendix D: Final report.** Caton, J.A.; Annamalai, K. Texas A and M Univ., College Station, TX (USA). Dept. of Mechanical Engineering. Dec 1989. 96p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-86MC23256. Order

Number DE90000450. Available from NTIS, PC A05/MF A01 - OSTI.

This report contains the listing for an engine cycle simulation computer program for modeling conventional medium-speed engines with overall equivalence ratios of less than .8 and with low or no swirl. (JDL)

19834 (DOE-tr–88-47) **Possibilities for using ceramic materials in engine construction.** (Einsatzchancen keramischer werkstoffe im motorenbau). Haus der Technik e.V., Essen (Germany, F.R.). Mar 1987. 238p. Translation of Einsatzchancen keramischer werkstoffe im Motorenbau, Haus der Technik E.V., March 10-11, 1987, pp. 1-215. Sponsored by U.S. DOE Management & Administration. Order Number DE90002742. Available from NTIS, PC A11/MF A01 - OSTI; GPO Dep.

This document contains work by various authors on the utilization of ceramics in engine construction. The studies include work on: effect of insulation measures on process values in diesel engines;combustion chamber insulation using ceramic materials; ceramic materials for specific engine applications; calculation and evaluation of life expectancy of mechanically stressed ceramic materials; computer analysis of compound arrangements for a thermally insulated passenger car diesel engine; nondestructive test methods for quality assurance for ceramic materials and components in engine construction; experiences with portliners in the passenger car Otto engine; ceramic components for reducing the cooling requirement for pistons; development of ceramic rotors for exhaust turbo-chargers; and friction behavior of ceramic materials and layers. (JL)

19835 (PB–90-854605/XAB) **Two stroke engines. June 1970-November 1989 (Citations from the COMPENDEX data base). Report for June 1970-November 1989.** National Technical Information Service, Springfield, VA (USA). Dec 1989. 148p. Available from NTISPC N01/MF N01.

Supersedes PB–89-853048.

This bibliography contains citations concerning the operating characteristics, performance, and applications of two-stroke cycle internal combustion engines. Topics include fuel injection, lubrication, and exhaust systems as well as emission control. Marine, motorcycle, and diesel engines are included. Factors contributing to engine noise are also discussed. (This updated bibliography contains 373 citations, 23 of which are new entries to the previous edition.)

3302 External Combustion Engines

Refer also to citation(s) 19769

3303 Electric-Powered Systems

Refer also to citation(s) 19625, 19712

19836 (DOE/NV/10418–2) **Single-shaft electric propulsion system technology development program, ETX-2 [Electric Transaxle-2]: Phase 2 technical report.** Ford Motor Co., Dearborn, MI (USA). Research Staff; General Electric Co., Schenectady, NY (USA). Corporate Research and Development Center. Apr 1989. 196p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC07-85NV10418. Order Number DE90006819. Available from NTIS, PC A09/MF A01 - OSTI.

In 1981, discussions between Ford and General Electric (GE) evolved a concept for an advanced electric vehicle powertrain that was subsequently presented to the US Department of Energy (DOE) as an unsolicited proposal. The concept involved a combination of technology from Ford and GE that would result in a unique powertrain based on a motor and transmission concentric with the drive wheel axis. Initial work suggested that the entire motor/transaxle combination could be expected to be smaller and lighter than the direct current (dc) motors that were in use in electric vehicles at that time and that the powertrain could be expected to be more efficient than other available powertrains. This program (ETX-1) was awarded to Ford Motor Company on April 15, 1982, in support of the DOE Electric and Hybrid Vehicles Program. During the course of the ETX-1 program it was established that the most likely first introduction of an electric vehicle would be in the form of a fleet of small commercial vans. To this end, the ETX-2 program was proposed. The resulting contract, number DE-AC07-87NV10418, was awarded by the Department of Energy and the effort commenced on March 14, 1985. The contract is administered by the DOE-Idaho Operations Office and is technically monitored by EG&G Idaho, Inc. 105 figs., 27 tabs.

19837 (EGG-M–89475) **Comparative evaluation of acoustical noise levels of Soleq Evcort EV and ICE [internal combustion engine] counterpart.** MacDowall, R.D. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1990]. 3p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC07-76ID01570. (CONF-900282–1: Annual Society of Acoustical Engineers congress, Detroit, MI (USA), 28 Feb 1990). Order Number DE90007016. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Idaho National Engineering Laboratory (INEL) evaluates Ev propulsion systems and components for the US Department of Energy (DOE) Electric and Hybrid Vehicle (EHV) Program. This paper describes an INEL study which compares the exterior and interior acoustic noise levels of an electric vehicle to its internal combustion engine (ICE) counterpart base vehicle, under various operating conditions. The electric vehicle was a converted 1988 Ford Escort station wagon, retrofitted with a DC electric powertrain developed by Soleq Corporation. A comparably-equipped gasoline-fueled ICE-powered Ford Escort station wagon provided the baseline acoustic noise levels with which to compare the electric vehicle. Measurements of the interior and exterior noise levels were obtained using a Bruel and Kjaer (B & K) Type 2231 Modular Precision Sound Level Meter. The tests were conducted in accordance with applicable Society of Automotive Engineer's (SAE) standard practices at Chrysler's Arizona Proving Grounds in Wittmann, Arizona. The results indicate that radiated interior and exterior acoustic noise levels of the electric vehicle were noticeably quieter under acceleration and idly conditions. However, under constant speed operation the electric and the ICE exhibited essentially equivalent interior and exterior noise levels. 8 refs., 2 tabs.

3304 Hybrid Systems

Refer also to citation(s) 19625, 19836, 19837

3307 Emission Control

19838 (PB–90-130402/XAB) **Low-altitude and low-temperature exhaust emissions tests of four vehicles on oxygenated gasoline blends and gasoline fuels. Technical report.** Barth, E.A. Environmental Protection Agency, Ann Arbor, MI (USA). May 1988. 11p. (EPA-AA-TEB–89/03). Available from NTIS, PC A03/MF A01.

The Coordination Research Council (CRC) initiated a project to study the effect of altitude and the use of oxygenated gasoline blends on motor vehicle exhaust emissions at 75 F and low temperature. The EPA MVEL provided four open-loop carbureted motor vehicles to be tested at low-altitude. The report describes the tests performed on the four motor vehicles. Test results, vehicle specifications, fuel specifications and emission results are included.

3308 Alternative Fuels

Refer also to citation(s) 19271, 19475, 19745, 19838

19839 **Alternative transport fuels: Experience and prospects.** . Sathaye, J. (Lawrence Berkeley Lab., CA (USA)). pp. 935 of The Electrochemical Society Spring meeting (extended abstracts). The Electrochemical Society, Pennington, NJ (1989). (CONF-890518–: 175. meeting of the Electrochemical Society, Los Angeles, CA (USA), 7-12 May 1989).

Alternative transport fuels such as CNG, LPG and ethanol are in use in any countries. The market share of alternative fuel vehicles now ranges from 1% in Canada to 4% in Italy to about 10% in New Zealand and Holland to 20% in Brazil. In the U.S. their share is much smaller. The primary motivation for promoting alternative fuels were similar: a desire for greater energy self-sufficiency, and

reduction of the sudden large expenditures for oil imports. In order to gain price and security benefits, the use of methanol is being investigated in the U.S. Methanol would be used in flexible fuel vehicles. Supply of methanol would be obtained from domestic and foreign natural gas. The authors report results from the study of options available for supply of methanol to the U.S. and the consequent price and security benefits that might be derived from it.

35 ARMS CONTROL

3501 Policy, Negotiations, and Legislation

Refer also to citation(s) 19448, 19449

3503 Verification

Refer also to citation(s) 20240

19840 (UCRL–102585) **On-site inspection for verification of compliance with treaties.** Dorn, D.W. Lawrence Livermore National Lab., CA (USA). Dec 1989. 12p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9004115–1: 2. Beijing seminar on arms control, Beijing (China), 3-10 Apr 1990). Order Number DE90006039. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

OSIs (On-Site Inspections) can be divided into three types of inspections: (1) routine inspections at declared facilities, (2) short-notice inspections at declared facilities, and (3) short-notice inspections at undeclared facilities. Routine inspections at declared facilities are basically cooperative measures, and will likely be confidence building. Short notice inspections at declared facilities can increase the difficulties of conducting non-complaint activities and can serve either as confidence building measures or as a more confrontational action. Short notice inspections at undeclared facilities are confrontational and are likely to be most useful to obtain information which will confirm that obtained through NTM (National Technical Means). Although some information will be compromised during conduct of an OSI, specific procedures to be followed prior to and during the course of the inspections can mitigate this loss. In addition, OSIs at declared facilities serve to enhance NTM and to provide an on-site presence. On the other hand, the short-notice inspections at undeclared facilities are unlikely to uncover gross violations and may well lead to very significant losses of national security information. It may be, though, that challenge or suspect-site inspections will provide a perceived increase in effective verification of compliance. This perception may be necessary in order for the national authorities to ratify the treaty.

36 MATERIALS

19841 (LA–11723-MS) **Manufacturing with advanced materials.** Los Alamos National Lab., NM (USA). Nov 1989. 25p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. Order Number DE90006977. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Los Alamos National Laboratory, in partnership with US industries and universities, proposes to build on its experience in process modeling, on-line sensors, artificial intelligence control systems, and materials processing technology to develop new ways of controlling manufacturing processes. This document provides a broad overview of Los Alamos National Laboratory's capabilities in the field of intelligent process control and encourages the transfer of technology that will lead to commercially feasible manufacturing processes using advanced materials.

3601 Metals and Alloys

Refer also to citation(s) 19163, 19168, 19182, 19246, 19353, 19375, 19377, 19390, 19396, 19397, 19398, 19399, 19400, 19401, 19402, 19403, 19404, 19546, 19547, 19549, 19600, 19602, 19603, 19604, 19605, 19606, 19788, 19899, 19905, 19953, 20050, 20082, 20097, 20116, 20136, 20438, 20617, 20803, 20805, 20807, 20818, 20819, 20820, 20970, 20994

19842 (AD-A–214108/3/XAB) **Stainless steel passivity. Report for 1 October 1988-30 September 1989.** Clayton, C.R. State Univ. of New York, Albany, NY (USA). 30 Sep 1989. 6p. Available from NTIS, PC A02/MF A01.

Additions of nitrogen to molybdenum bearing and (essentially) Mo free stainless steels result in much higher improvements in general corrosion resistance and pitting resistance. The most dramatic improvements are observed in the Mo-bearing steels. This enquiry is attempting to model the roles of N and Mo in passivity. X-Ray photoelectron spectroscopy (XPS) was utilized along with electrochemical analysis and a new surface doping treatment devised for this work in order to facilitate this study.

19843 (BNL–43662) **Glancing angle XAFS [x-ray absorption fine structure] and x-ray reflectivity studies of transition-metal/aluminum interfaces.** Heald, S.M.; Barrera, E.V.; Chen, Huaiyu. Brookhaven National Lab., Upton, NY (USA). [1990]. 20p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016;AS05-80ER10742. (CONF-900497–1: Structure of surfaces and interfaces as studied by synchrotron radiation: Faraday disc. 89, Manchester, NH (USA), 4-6 Apr 1990). Order Number DE90005575. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The combination of glancing angle x-ray absorption fine structure (XAFS) and x-ray reflectivity measurements provide detailed structural information about interfaces. Results from transition-metal/Al interfaces are used to illustrate the capabilities of the techniques. Reflectivity measurements are used to determine the thickness and density profile of the films, along with the amount of interfacial or surface roughness. The XAFS measurements provide information about the local bonding at the interface, and are well suited for studying the interfacial chemistry. Of interest is the role of impurities such as oxygen in modifying interface structure and thermal stability. For Cu/Al, Ni/Al, and Cr/Al a small amount of interfacial oxygen is found to strongly affect both the initial interface structure, and the response of the interface to thermal annealing. For Ni/Al it is also found that interfacial oxygen affects primarily the interface reaction, while oxygen within the Al layer suppresses the grain boundary reaction channel. 16 refs., 8 figs.

19844 (BNL–43762) **Magnetic phase diagrams of UCu_2Si_2 and UNi_2Si_2.** McElfresh, M.W. (IBM Watson Research Center, Yorktown Heights, NY (USA)); Rebelsky, L.; Torikachvili, M.S.; Borges, H.; Reilly, K.; Horn, S.; Maple, M.B. Brookhaven National Lab., Upton, NY (USA). [1989]. 11p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract AC02-76CH00016;FG03-86ER45230. Grant DMR-8501866. (CONF-891117–14: 34. conference on magnetism and magnetic materials, Boston, MA (USA), 28 Nov - 1 dec 1989). Order Number DE90007142. Available from NTIS, PC A03/MF A01; OSTI; INIS.

Magnetization measurements performed on UCu_2Si_2 and UNi_2Si_2 are reported. The compound UCu_2Si_2 appears to undergo both an antiferromagnetic (AFM) transition at T = 107 K and a ferromagnetic (FM) transition at $T_c \approx$ 103 K. While the second transition at T_c has already been reported, the AFM phase was apparently overlooked in earlier studies. The compound UNi_2Si_2 undergoes a transition at T ≈ 97 K, which was previously shown to be AFM by neutron scattering; we present evidence for the occurrence of a FM state below the AFM transition. 11 refs., 3 figs.

19845 (CEGB-RD-M–1785/RR89) **The application of welding technology in power plant manufacture.** Price, A.T.; Chew, B. Central Electricity Generating Board, Southampton (UK). Marchwood Engineering Labs. Feb 1989. 24p. Order Number DE90616309. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

A strategy is presented for the application of welding technology in the manufacture of power plant. A flow chart description is adopted in the present paper to provide a general framework outlining the sequence of activities leading to manufacture. The broad chronological order of events is treated under the three headings, Component Design, Welding Development, and Implementation. Important factors that have to be considered at each of these

stages are shown in subsidiary flow charts together with short notes to provide context and an aide memoire for those involved in welding technology. (author).

19846 (CONF-900403–2) **Evaluation of the response of aluminum alloys to single and multiple particle impacts.** Keiser, J.R. (Oak Ridge National Lab., TN (USA)); Rao, M. Oak Ridge National Lab., TN (USA). [1989]. 17p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC05-84OR21400. From Corrosion '90; Las Vegas, NV (USA); 23-27 Apr 1990. Order Number DE90003689. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Samples of annealed 1100 aluminum and 7075-T6 aluminum were eroded to steady-state conditions in a multiple particle erosion system. The samples were sectioned through the eroded areas, and a mechanical properties microprobe was used to measure the hardness of the material. The oblique multiple particle impacts produced a rippled surface with the hardness at the top of the wave crests approximately equal to that in the valleys. However, the total depth of hardening was significantly greater in material below the wave crests and was a function of the material for both wave crests and valleys. The depth of hardened material below the wave crest was about equal to the height of the wave plus the depth of hardening below the valley. 23 refs., 5 figs.

19847 (DOE/ER/13985–1) **Structure and reactivity of model thin film catalysts: Annual performance report, 16 January 1989–15 January 1990.** Madey, T.E. Rutgers–the State Univ., Piscataway, NJ (USA). Serin Physics Lab. 31 Aug 1989. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-89ER13985. Order Number DE90007365. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The purpose of this project is to characterize the structure and reactivity of model bimetallic catalysts, e.g., ultrathin films of Pt deposited on single crystal surface of tungsten. Studies during this reporting period (January 15, 1989 to the present) have involved a comparison between the atomically smooth W(110) surface and the atomically rough W(111) surface using several ultrahigh vacuum surface science methods (low energy electron diffraction, LEED, Auger electron spectroscopy, AES, and thermal desorption spectroscopy, TDS). In addition, we have used scanning tunneling microscopy (STM) to provide a microscopic view of Pt induced surface structures with Angstrom level resolution. On W(110), a single Pt monolayer is stable upon heating to >1800K. It grows in a layer-by-layer mode at 300K, but Pt coverages in excess of one monolayer will cluster into 3-dimensional bulk Pt crystallites upon annealing to $\gtrsim$ 800K. When W(111) is covered by $\gtrsim 1 \times 10^{15}$ Pt atoms/cm^2 and heated in the range 800–1600 K, the surface undergoes a massive restructuring to form microscopic facets. At 1200 K, the average facet dimensions are ~100Å, and the dominant facet orientations is W(211). The faceting appears to be driven by a Pt-enhanced anisotropy in the surface free energy. To the best of our knowledge, the only other reports of faceting induced by a single monolayer of metal on a metal surface are based on field emission microscopy. The PI joined Rutgers in Fall 1988, and initiated this project shortly afterwards. It is an outgrowth of work performed by the PI and his colleagues at the National Institute of Standards and Technology (formerly NBS). 8 refs., 2 figs.

19848 (DOE/ER/45315–3) **The effects of gradients on boundary stability: Progress report, 15 February 1989–31 December 1989.** Hackney, S.A.; Plichta, M.R.; Lee, J.K. Michigan Technological Univ., Houghton, MI (USA). [1989]. 20p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-87ER45315. Order Number DE90007428. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report presents a short summary of the work completed during the first two and a half years of the DOE-funded program, "The Effects of Gradients on Boundary Stability" (FG02-87ER45315). The results are presented in three categories, designated by the type of boundary being studied (grain boundaries, surfaces, and phase boundaries). 57 refs., 3 figs.

19849 (FhG-IWM-W–3/89) **Experimental studies on elastic/plastic fracture of a pressure vessel steel under dynamic stress.** Boehme, W. Fraunhofer-Institut fuer Werkstoffmechanik, Freiburg im Breisgau (Germany, F.R.). Jan 1989. 42p. (In German). Contract BMFT 1500 488 A. Order Number DE90753177. Available from NTIS (US Sales Only), PC A03/MF A01.

The aim of the reasearch was the characterization of the ductile fracture behaviour pressure vessel steel (22NiMoCr37) under high load rates on the basis of the J integral concept. For this purpose, impact experiments were made with large bending test specimens in a hammer test facility and with Charpy test specimens in a pendulum ram impact testing installation. The test specimens were provided with lateral notches and material fatigue cracks. From the measured hammer load signals the J integral value was determined. By variance of the available impact energy in multiple test specimen techniques different crack elongations were set up and thereby dynamic J_R curves determined. Investigations of the fracture surfaces and their vertical ground sections indicated that adjoining the 'stretched zone' is an area in which next to the ductile main crack a side crack of up to about 3mm length can appear. This crack length correlates approximately with the crack length where a change in the gradient could be noted in the J_R curve. Because of the reciprocal relief of the cracks these multiple crack formation requires higher energy per crack propagation than for a single crack so that this process is viewed as the cause for the steep J_R curve in its initiation area. (orig./MM).

19850 (FhG-IWM-W–5/89) **Strength and toughness of ferritic structural steels between 20deg C and 400deg C.** Memhard, D. Fraunhofer-Institut fuer Werkstoffmechanik, Freiburg im Breisgau (Germany, F.R.); Technische Hochschule Aachen (Germany, F.R.). Fakultaet fuer Bergbau und Huettenwesen. May 1989. 223p. (In German). Order Number DE90753176. Available from NTIS (US Sales Only), PC A10/MF A01.

The objective of the study was to quantitativley describe within the temperature range of 20deg C and 400deg C the strength and toughness behaviour of construction steels with diverse characteristics in dependence of stress rate and temperature and furthermore to evaluate the time dependence of material behaviour by comparison of experiments under tension load and constant loads. To this end tension tests at expansion rates of 10^{-2} to 10^{-7} s^{-1} of the steels 15 MnNi 6 3 and MnMoNi 5 5 and on screw steel 21 CrMoV 5 7, relaxation and short term creep tests were conducted. Parallel to this fracture mechanics tests on CT-specimens with a tension rate of 10^{-1} to 10^{-4} mm/s and creep test under constant load were conducted. The three basic test enabled a comprehensive description of the material behaviour under uniaxial tensile load. In the field of ductile material failure where the crack propagation is accompanied by noticeable plastic deformation of the cracked structure, the temperature and tension rate dependence of the flow behaviour on the crack resistance behaviour is noticeable. In contrast to crack resistance behaviour in path-controlled experimental procedures time-dependent plastic deformations in short term creep tests can no longer be neglected. (orig./MM) With 129 figs., 4 tabs., 154 refs.

19851 (KU-HCOE-FL2-R–88-9) **Temperature and fluence effects in lead implanted cobalt single crystals.** Johansen, A. (Copenhagen Univ. (Denmark). Fysisk Lab. (Denmark)); Sarholt-Kristensen, L.; Johnson, E.; Steenstrup, S.; Chernysh, V.S. Copenhagen Univ. (Denmark). H.C. Oersted Inst. 1988. 29p. Order Number DE90617448. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The channeled sputtering yields of the hcp and fcc phases of cobalt depend on the crystal structure and the radiation induced damage. Earlier irradiations of cobalt with argon ions channeled in the $<0001>_{hcp}$ direction give sputtering yields higher than expected in the temperature range 100-350deg C. This effect was attributed to a combination of radiation induced damage and a possible implantation induced hcp –> fcc phase transition. Sputtering yields for cobalt single crystals irradiated with 150 keV Pb^+ ions along the <0001> direction of the hcp phase and the <111> direction of the fcc phase have been measured using the weightloss method. The radiation damage and the amount of lead retained in the implanted surface has been investigated by 'in situ' RBS/channeling analysis. Measured partial sputtering yields of lead $\simeq$ 1 atom/ion indicate preferential sputtering of lead atoms. (orig.).

19852 (LA-UR-90-23) **Impression creep characterization of TiAl weldments.** Gibbs, W.S.; Aikin, R.M. Sr.; Martin, P.L.; Patterson, R.A. Los Alamos National Lab., NM (USA). [1990]. 10p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-900425-2: 4. international conference on creep and fracture of engineering materials and structures, Swansea (UK), 1-6 Apr 1990). Order Number DE90007832. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Impression Creep technique has been applied to XD™ TiAl weldments to evaluate the local creep resistance of the fusion zone and the heat affected zone. The material used in this study was TiAl produced by Martin Marietta Research Laboratories, using their patented ingot processing which incorporates 1 to 10 μm diameter particles of carbide, nitride or boride compounds. The impression creep technique uses a small indenter to locally evaluate the creep resistance of the heterogeneous microstructure developed during the welding process. The indenters used in this investigation were 1 mm in diameter. Results obtained from the impression creep tests are compared to results obtained from constant stress tensile creep tests on the base material. Creep resistance of the heat affected zone and the fusion zone are compared to and contrasted with the base material strength. 19 refs., 2 figs., 2 tabs.

19853 (LA-UR-90-24) **Creep behavior of alloys based on TiAl containing TiB_2 and TiN particulates.** Martin, P.L. (Los Alamos National Lab., NM (USA)); Carter, D.H.; Aikin, R.M. Sr.; Aikin, R.M. Jr.; Christodoulou, L. Los Alamos National Lab., NM (USA). [1990]. 12p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-900425-3: 4. international conference on creep and fracture of engineering materials and structures, Swansea (UK), 1-6 Apr 1990). Order Number DE90006489. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Ordered alloys based on the $L1_0$ crystal structure compound TiAl were tested in constant stress creep. The alloys ranged from 45 to 47 at. % Al with and without V substitutions. The ingot processing, utilizing the XD™ technique, incorporated 1 to 5 μm diameter particles of boride or nitride compounds. Emphasis was placed on characterizing the initial stages of creep using digital data acquisition and analysis in the range 70 to 280 MPa stress and 760 to 850°C temperature. When TiN (converting to Ti_2AlN in processing) and TiB_2 are both added to the matrix, the creep properties are significantly improved. Fine particles were observed to decorate dislocations and to have nucleated homogeneously within the TiAl grains. 16 refs., 7 figs., 3 tabs.

19854 (LA-UR-90-25) **Deformation and fracture of TiAl + W at elevated temperatures.** Martin, P.L. (Los Alamos National Lab., NM (USA)); Lipsitt, H.A. Los Alamos National Lab., NM (USA). [1990]. 10p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-900425-1: 4. international conference on creep and fracture of engineering materials and structures, Swansea (UK), 1-6 Apr 1990). Order Number DE90006490. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The ternary alloy, Ti - 49 at% Al -2 at. % W, was produced using Rotating Electrode Powder (REP) compacted by hot extrusion. The tensile properties of this alloy (strength, ductility and fracture mode) were studied from room temperature to 900°C. Constant load creep properties were measured from 700 to 900°C and analyzed using conventional power law equations to calculate the stress exponent and activation energy. These parameters were approximately 4 and 400 KJ/mole respectively. TEM examination showed that the W was held in solid solution during the tensile and creep deformation when the material was tested in the 'as-extruded' condition. These results are interpreted as evidence for solid solution strengthening of the TiAl matrix by the W solute. 13 refs., 3 figs., 4 tabs.

19855 (LA-UR-90-459) **Computer simulation of recrystallization in the presence of second phase particles.** Rollett, A.D. (Los Alamos National Lab., NM (USA)); Srolovitz, D.J.; Doherty, R.D.; Anderson, M.P.; Grest, G.S. Los Alamos National Lab., NM (USA). [1989]. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-8910304-2: TMS meeting on simulation and theory of evolving microstructures, Indianapolis, IN (USA), Oct 1989). Order Number DE90007531. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Recrystallization in the presence of inert second-phase particles has been simulated with a Monte Carlo technique. The technique is the same one as has been employed successfully to model grain growth, recrystallization and grain growth in the presence of second-phase particles. The results show that at low stored energies, the particles retard the growth of recrystallization nuclei and can prevent the recrystallization process from going to completion. At high enough stored energies, however, growth is not impeded such that the particles do not affect the kinetics of recrystallization. Post-recrystallization is strongly affected by the presence of particles because grain growth is inhibited and the microstructures to be less equiaxed than in grain growth. 15 refs., 7 figs.

19856 (LA-UR-90-654) **Modification of surface mechanical properties of high-chromium tool steel by carbon-implanted codeposited Fe-Ti films.** Hirvonen, J-P.; Nastasi, M.; Jervis, T.R.; Zocco, T.G. Los Alamos National Lab., NM (USA). [1990]. 23p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-36. Contract DEW-88-24. (CONF-900419-1: 8. international triennial conference on thin films and the 17th international conference on metallurgical coatings, San Diego, CA (USA), 1-6 Apr 1990). Order Number DE90007502. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

An iron-titanium film 300 nm thick was deposited on a tool steel (1.55% C, 0.3% Si, 0.3% Mn, 12% Cr, 0.8% Mo, and 0.8% V) by coevaporation of Fe and Ti. Subsequently this surface film was implanted with carbon at energies of 55, 120, and 200 keV to a total fluence of 1.24×10^{18} C^+/cm^2. This treatment produced a surface hardness of 15 GPa. The effect of this coating on unlubricated wear and friction was tested in air at a relative humidity of 10% in a pin-on-disc tester using a 440C pin as a counterface. The sliding mechanism of the untreated substrate was found to be based on the transfer of pin material and subsequent growth of uneven oxide hillocks on the wear track. Oxide scales were observed also on a wear scar of the pin, presumably as a result of back-deposition. In contrast, the sliding mechanism on the coated sample was drastically different. A more uniform transfer film originating in the coating was found on the pin, resulting in sliding between identical materials. No wearthrough of the coating occurred during the test of 5000 cycles at a Hertzian pressure of 835 MPa, and the surface of the wear track showed extreme smoothness to the very end of the test. The friction coefficient was decreased from 0.7 for the uncoated to 0.2 for the coated surface. The wear track on the coated surface was also found to be slightly oxidized, as determined by a nuclear reaction [$^{16}O(d,p)^{17}O$]. The reduction of friction was mainly attributed to the increased hardness of the counterfaces and an adequate but controlled oxidation. 15 refs., 7 figs., 2 tabs.

19857 (LA-UR-90-660) **Microstructural simulations of dynamic recrystallization.** Rollett, A.D. (Los Alamos National Lab., NM (USA)); Srolovitz, D.J.; Luton, M.J. Los Alamos National Lab., NM (USA). [1989]. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-8910304-3: TMS meeting on simulation and theory of evolving microstructures, Indianapolis, IN (USA), Oct 1989). Order Number DE90007504. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A Monte Carlo model for the simulation of static recrystallization and grain growth has been adapted for dynamic recrystallization by adding recrystallization nuclei and stored energy continuously with time. The results of the simulations have shown that many of the essential features of dynamic recrystallization are reproduced. The stored energy of the system, which may be interpreted as the flow stress, goes through a maximum and then decays, monotonically under some conditions and otherwise in an oscillatory manner. The principal parameters that were varied were the rate of adding stored energy, ΔH, and the rate of adding nuclei, ΔN. As ΔH increases, for fixed ΔN, the oscillations decay more rapidly and the asymptotic stored energy rises. As ΔN increases, again the oscillations decay more rapidly but the asymptotic stored energy decreases. The mean grain size of the system also oscillates in a similar manner to the stored energy but 90° out of phase. Necklacing of the prior grain structure by new grains is observed for low ΔH and high ΔN; it is however, not an invariable feature of grain

refinement, i.e,. cases where the dynamic grain size is smaller than the initial grain size. All these results were obtained without the addition of special parameters to the model such as a critical strain for the initiation of recrystallization. 9 refs., 6 figs.

19858 (LBF-FB-185(1989)) **Corrosion fatigue of stainless cast steel alloys G-X 5 CrNi 13 4 and G-X 5 CrNi 17 4 for runners of hydraulic machines and pumps.** Sonsino, C.M.; Dieterich, K. Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung e.V., Darmstadt (Germany, F.R.). Inst. fuer Betriebsfestigkeit. 1989. 68p. (In German). Order Number DE90753285. Available from NTIS (US Sales Only), PC A04/MF A01.

In this project the influence of different corrosive media on the fatigue behaviour of stainless cast steel alloys with 13 and 17% chromium content for hydraulic machines was investigated in the high cycle range ($10^6 < N < 10^8$). Hereby the possible range of media was covered by using tap water with 28 ppm chlorides, 10 mMol NaCl, as well as 1% NaCl and in the case of the higher alloyed steel additionally artificial sea water without and with cathodic protection. Further the influence of high mean stresses due to rotation of runners was also analysed. The results obtained on the lost of fatigue strength in dependence of corrosive media, mean stress and cycles to failure enable an aimed material's selection as well as an appropriate design and increase the reliability and security of water power machines. (orig.).

19859 (LBL-27775) **Creep in shear of experimental solder joints.** Tribula, D.; Morris, J.W. Jr. Lawrence Berkeley Lab., CA (USA). Sep 1989. 29p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-891208-29: Winter annual meeting of the American Society of Mechanical Engineers, San Francisco, CA (USA), 10-15 Dec 1989). Order Number DE90007062. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Thermal fatigue failures of solder joints in electronic devices are a great concern in the electronics industry. Since the fatigue load is often in shear the details of thermal fatigue failure in shear are of particular interest. Recent work indicates that similar failure mechanisms operate in both thermal fatigue in shear and unidirectional creep in shear. Additionally, since the operative temperatures during thermal fatigue represent high solder homologous temperatures, creep deformation is certainly involved. These factors and the relative ease of conducting creep experiments encourage the study of solder joints under shear creep conditions. This work presents steady state shear creep rate vs shear stress data for several solder compositions, including the binary eutectic alloy and Pb-Sn alloyed with small amounts of Bi, Cd, In, and Sb, in a joint configuration. These data indicate that conventional creep mechanisms operate in the temperature and shear strain rate ranges studied. Extensive microstructural information is also reported. The microstructural evolution under creep conditions indicates that the instability of the as-cast binary Pb-Sn eutectic microstructure initiates creep failure. Changes of the as-solidified microstructure with the third element addition are reported as are the microstructural responses of each of these alloys to creep deformation. The efficacy of postponing the microstructural instability with the addition of small amounts of ternary elements is discussed. 27 refs., 13 figs., 1 tab.

19860 (LBL-28170) **Magnetic properties of surfaces and interfaces.** Chrzan, D.C. (California Univ., Berkeley, CA (USA). Dept. of Physics). Lawrence Berkeley Lab., CA (USA). Nov 1989. 200p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90007348. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

A survey of the magnetic properties of three types of planar defects is presented: a model interface in an Ising antiferromagnet, a model of the surface of an antiferromagnet, and a realistic calculation of the magnetic properties of stacking defects in a bulk ferromagnet. The simplest interface studied is the antiphase boundary in the nearest-neighbor face-centered-cubic Ising antiferromagnet. The properties of this defect are understood by means of the construction and solution of an exactly solvable thermodynamic model which mimics the boundary's properties. The implications for further calculations using the nearest-neighbor face-centered-cubic Ising model are explored. This thesis then examines the effects of introducing a free surface in a real antiferromagnetic semiconductor, EuTe. The complex magnetic structures of the {001} faces of this material, which include spin structures incommensurable with the underlying lattice, are understood in terms of a classical Heisenberg Hamiltonian. Finally, the magnetic properties of {111} stacking faults in nickel are investigated utilizing a self-consistent, layered Korringa-Kohn-Rostoker formalism based on the local-density approximation to density-functional theory. Very simple expressions for the spin polarization and internal energy are developed. The range of behaviors displayed by these three systems is remarkable in its diversity, and yet the underlying mechanisms are all similar. This similarity suggests that many of the tools necessary for understanding the magnetic properties of surfaces and interfaces are readily available.

19861 (N-90-11853) **Precipitation strengthened high strength, high conductivity Cu-Cr-Nb alloys produced by chill block melt spinning. Final report Ph.D. Thesis.** Ellis, D.L.; Michal, G.M. Case Western Reserve Univ., Cleveland, OH (USA). Sep 1989. 231p. (NASA-CR-185144;NAS-1.26:185144). Available from NTIS, PC A11/MF A02.

A series of Cu-based alloys containing 2 to 10 a/o Cr and 1 to 5 a/o Nb were produced by chill block melt spinning (CBMS). The melt spun ribbons were consolidated and hot rolled to sheet to produce a supersaturated Cu-Cr-Nb solid solution from which the high melting point intermetallic compound Cr2Nb could be precipitated to strengthen the Cu matrix. The results show that the materials possess electrical conductivities in excess of 90 percent that of pure Cu at 200 C and above. The strengths of the Cu-Cr-Nb alloys were much greater than Cu, Cu-0.6 Cr, NARloy-A, and NARloy-Z in the as-melt spun condition. The strengths of the consolidated materials were less than Cu-Cr and Cu-Cr-Zr below 500 C and 600 C respectively, but were significantly better above these temperatures. The strengths of the consolidated materials were greater than NARloy-Z, at all temperatures. The GLIDCOP possessed similar strength levels up to 750 C when the strength of the Cu-Cr-Nb alloys begins to degrade. The long term stability of the Cu-Cr-Nb alloys was measured by the microhardness of aged samples and the growth of precipitates. The microhardness measurements indicate that the alloys overage rapidly, but do not suffer much loss in strength between 10 and 100 hours which confirms the results of the electrical resistivity measurements taken during the aging of the alloys at 500 C. The loss in strength from peak strength levels is significant, but the strength remains exceptionally good. Transmission electron microscopy (TEM) of the as-melt spun samples revealed that Cr2Nb precipitates formed in the liquid Cu during the chill block melt spinning, indicating a very strong driving force for the formation of the precipitates. The TEM of the aged and consolidated materials indicates that the precipitates coarsen considerably, but remain in the submicron range.

19862 (N-90-12715) **Determination of the gaseous hydrogen ductile-brittle transition in copper-nickel alloys.** Parr, R.A.; Johnston, M.H.; Davis, J.H.; Oh, T.K. National Aeronautics and Space Administration, Huntsville, AL (USA). George C. Marshall Space Flight Center. Feb 1985. 17p. (NASA-TM-86494;NAS-1.15:86494). Available from NTIS, PC A03/MF A01.

A series of copper-nickel alloys were fabricated, notched tensile specimens machined for each alloy, and the specimens tested in 34.5 MPa hydrogen and in air. A notched tensile ratio was determined for each alloy and the hydrogen environment embrittlement (HEE) determined for the alloys of 47.7 weight percent nickel to 73.5 weight percent nickel. Stacking fault probability and stacking fault energies were determined for each alloy using the x ray diffraction line shift and line profiles technique. Hydrogen environment embrittlement was determined to be influenced by stacking fault energies; however, the correlation is believed to be indirect and only partially responsible for the HEE behavior of these alloys.

19863 (OEFZS-A-1469) **On micro-pores in sintered molybdenum.** Blaschko, O. (Vienna Univ. (Austria). Inst. fuer Experimentalphysik); Eder, O.J.; Posch, M. Oesterreichisches Forschungszentrum Seibersdorf G.m.b.H. (Austria). Jul 1989. 31p. (PH-472/89). Available from the Austrian Research Centre

Seibersdorf, A-2444 Seibersdorf (Austria). Available from the Austrian Research Centre Seibersdorf, A-2444 Seibersdorf (Austria).

Limited Distribution.

Small Angle Neutron Scattering (SANS) has been used to investigate the change of the pore structure during the final stage of the compaction process of sintered Molybdenum (sintering times between 1 - 16 h, sintering temperatures at 1800 and 2000°C, were investigated, the samples were provided by Metallwerke Plansee, Reutte, Austria). Conventional SANA is sensitive to pores of sizes in the range 10A to 10^3A. Double Crystal Neutron Diffractions (DCND) is sensitive to a size range between 10^3A to 10^5A with a reasonable overlap between the ranges of the two techniques. It is found that the total pore volume decreases with sintering time, while at the same time the size of the pores tends to increase. This process has some similarity to the coarsensing process observed in decomposing alloys. The SANS of the sintered samples is compared to the SANS of a sample produced by melting. A model is proposed which describes the change of the distribution assuming 'large pores' to absorb and desorb 'small pores' which themselves can migrate in the samples and may escape through the surface of the sample. 6 refs., 9 figs. (Author, shortned by qui).

19864 (ORNL–6483) **Alloy development and mechanical properties of nickel aluminide (Ni_3Al) alloys.** Liu, C.T.; Sikka, V.K.; Horton, J.A.; Lee, E.H. Oak Ridge National Lab., TN (USA). Aug 1988. 55p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. Order Number DE90007609. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This report summarizes recent alloy development of nickel aluminides for structural applications. Boron-doped Ni_3Al showed severe embrittlement when tested in oxidizing environments above 300°C. The embrittlement is due to a dynamic effect, which can be alleviated by alloying with 8 at. % Cr. The chromium-modified aluminide alloys possess a good combination of strength and ductility for use at temperatures to 1000°C. The hot ductility and fabricability of the aluminide alloys can be substantially improved by reducing the zirconium content to below 0.35 at. %. Material processing of large aluminide heats has been demonstrated by both conventional and innovative techniques. Mechanical properties of the aluminide alloys were characterized at temperatures to 1200°C. Grain size, which is the main difference between the materials produced by the various processing techniques, is the major metallurgical parameter that strongly influences the mechanical properties of the aluminide alloys. 35 refs., 20 figs., 11 tabs.

19865 (ORNL/FTR–3529) **[Deformation and fracture of ordered intermetallic compounds]: Foreign trip report, December 15, 1988–January 14, 1990.** Yoo, M.H. Oak Ridge National Lab., TN (USA). 14 Feb 1990. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90007422. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The research at Tohoku University was primarily on mechanistic interpretation of the available mechanical properties of ordered intermetallic alloys. This included initiation mechanisms of the active slip and twinning, anomalous yield and flow behavior, and electron microscopic analyses of dislocation substructures. The assignee presented invited papers on deformation and fracture behavior of ordered intermetallic compounds at technical society meetings, and participated in topical symposia and workshops. The assignee became better acquainted with the Japanese strategy on base technology development for advanced structural materials.

19866 (PB–90-854589/XAB) **Frictionless coatings. September 1970-October 1989 (Citations from the Compendex data base). Report for September 1970-October 1989.** National Technical Information Service, Springfield, VA (USA). Dec 1989. 55p. Available from NTISPC N01/MF N01.

Supersedes PB–88-870654.

This bibliography contains citations concerning the properties and applications of frictionless coatings. Coatings applied to metals and alloys used in extreme high- or low-temperatures environments are examined. Wear characteristics, structure, and performance evaluations of specific coatings are included. Applications in bearings, combustion cylinders, shafts, guideways, and bushings are discussed. (This updated bibliography contains 114 citations, 33 of which are new entries to the previous edition.)

19867 (SAND–90-0152C) **Time-resolved measurements of solidification and undercooling in metals and alloys.** Atwater, H.A. (California Inst. of Tech., Pasadena, CA (USA)); West, J.A.; Smith, P.M.; Aziz, M.J.; Tsao, J.Y.; Peercy, P.S.; Thompson, M.O. Sandia National Labs., Albuquerque, NM (USA). [1989]. 7p. Sponsored by U.S. DOE Defense Programs; National Science Foundation. DOE Contract AC04-76DP00789. (CONF-891119–98: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989). Order Number DE90007074. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We have performed nanosecond-resolution measurements of the lateral electrical resistivity of thin metal films on insulating substrates. Comparison of transient resistivity measurements with optical reflectivity measurements and heat-flow calculations permits the determination of the position and velocity of a planar crystal/melt in interface, and an estimate of undercooling during pulsed laser melting of metals. We report detailed results for rapid solidification of Ni, including the observation of hypercooling of liquid Ni. 14 refs., 3 figs., 1 tab.

19868 (SAND–90-0395) **FWP executive summaries: Basic energy sciences materials sciences programs.** Sandia National Labs., Albuquerque, NM (USA). Feb 1990. 46p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789. Order Number DE90006373. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The BES Materials Science program at Sandia Albuquerque has the central theme of Scientifically Tailored Materials. The major objective of this program is to combine Sandia's expertise and capabilities in the areas of solid state sciences, advanced atomic-level diagnostics and materials-processing science to produce new classes of tailorable materials for the US energy industry, the electronics industry and for defense needs. Current research in this program includes the physics and chemistry of ceramics, the use of energetic particles for the synthesis and study of materials, high-temperature and organic superconductors, tailored surfaces for materials applications, chemical vapor deposition sciences, strained-layer semiconductors, advanced growth techniques for improved semiconductor structures and boron-rich very high temperature semiconductors. A new start just getting underway deals with the atomic level science of interfacial adhesion. Our interdisciplinary program utilizes a broad array of sophisticated, state-of-the-art experimental capabilities provided by other programs. The major capabilities include several molecular-beam epitaxy and chemical-vapor-deposition facilities, electron- and ion-beam accelerators, laser-based diagnostics, advanced surface spectroscopies, unique combined high-pressure/low-temperature/high-magnetic-field facilities, and the soon to be added scanning tunneling and atomic force microscopies.

19869 (SERI/PR–212-3494) **Solid State Photovoltaic Research Branch annual report, FY 1988.** Solar Energy Research Inst., Golden, CO (USA). Jul 1989. 265p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Order Number DE89009463. Available from NTIS, PC A12/MF A01 - OSTI; GPO Dep.

This report summarizes the progress of the Solid State Photovoltaic Research Branch of the Solar Energy Research Institute (SERI) from October 1, 1987, through September 30, 1988. Six technical sections of the report cover the main areas of SERI's in-house solid state photovoltaic research: Semiconductor Crystal Growth, Amorphous Silicon Research, Polycrystalline Thin Films, III-V High-Efficiency Photovoltaic Cells, Solid State Theory, and Laser Raman and Photoluminescence Spectroscopy. Principal achievements and experimental details of current work are covered in each section. Each section was written by the group leader principally in charge of the work. The task in each case was to explain the purpose and major accomplishments of the branch's work in the context of the US Department of Energy's National Photovoltaic Research Program plans. Each of the six papers in this analytic has a separate abstract.

19870 (SERI/PR–212-3494, pp. 10-61) **Semiconductor crystal growth research.** Ciszek, T.F. Solar Energy Research Inst., Golden, CO (USA). Jul 1989. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. In *Solid State Photovoltaic Research Branch annual report, FY 1988.* Order Number DE89009463. Available from NTIS, PC A12/MF A01 - OSTI.

Crystal Growth Research Group activities during this reporting period were focused in three diverse materials areas – silicon, compound semiconductors, and superconductors. The crystal growth work in silicon continued an effort to quantify the effects of crystal growth parameters on minority charge carrier lifetime. Lifetime is the primary performance indicator for silicon PV devices. We want to understand how it is influenced by the conditions of crystal growth in order to form a basis for making intelligent choices about which growth parameters may be relaxed when low-cost growth processes are contemplated. The specific aspects studied in this period were microdefect effects on lifetime and the effect of the growth rate and the crystal cooling rate on the formation of microdefects. 92 refs., 41 figs., 2 tabs.

19871 (UCRL–102284) **Time-dependent failure of silver-interlayer diffusion bonds between non-deforming base-metals.** Kassner, M.E. (Lawrence Livermore National Lab., CA (USA)); Rosen, R.S.; Henshall, G.A.; Challenger, K.D. Lawrence Livermore National Lab., CA (USA). 22 Nov 1989. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900425–4: 4. international conference on creep and fracture of engineering materials and structures, Swansea (UK), 1-6 Apr 1990). Order Number DE90006925. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Silver-interlayer diffusion-bonds, fabricated at low temperatures using planar-magnetron sputtering, exhibit very high tensile strengths. Earlier work has shown that these joints undergo delayed failure at relatively low tensile stresses at ambient temperature for the case in which plasticity occurs in the base materials. Failure apparently occurs by a microvoid coalescence mechanism at the bond interfaces. Delayed tensile failures were investigated in this study for the case in which the applied stress does not produce any plastic deformation in the base metal. Failure occurs and appears to be controlled by time-dependent plasticity within the silver interlayer, which is governed by the effective stress in the interlayer. The plasticity causes cavity nucleation and, eventually, interlinkage and failure. These findings are believed to be generally applicable to any thin interlayer bond, including those prepared by processes different than physical vapor-deposition. 25 refs., 5 figs.

19872 (UCRL–102637) **Issues concerning shock temperatures of iron and other metals.** Nellis, W.J.; Yoo, C.S. Lawrence Livermore National Lab., CA (USA). Dec 1989. 20p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-8906285–1: Ironworkers convention workshop on the physics of iron, Los Alamos, NM (USA), 14-16 Jun 1989). Order Number DE90007259. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Issues which need to be addressed to obtain accurate thermodynamic shock temperatures of metals are discussed. 24 refs., 3 figs.

19873 (WSRC-MS–90-14) **The visioplastic method for analysis of large extrusion strains.** Peacock, H. (Westinghouse Savannah River Co., Aiken, SC (USA)); Berghaus, D. Westinghouse Savannah River Co., Aiken, SC (USA). 1990. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035;AC09-76SR00001. Order Number DE90007360. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Large plastic strains are produced when a metal billet is pressed through an extrusion die. This paper describes a method for obtaining the distribution of these strains during axisymmetric extrusion. The method is experimental-numerical and is based on a study of laminar flow lines produced in the extruded material. Several results are obtained using this analysis. These include the effects of extrusion tooling temperature and extrusion ratio. The method is also modified to study extrusion of powder metal, where the variable density invalidates the usual assumption of incompressibility. The flowline-strain relationship was originally set forth by Thomsen, Yang and Kobayashi and is referred to as viscoplasticity. The method described in this paper proceeds from that developed by Medrano and Gillis for axisymmetric extrusion. There are several differences. The experimental procedure has been changed to permit extrusion analysis at the high aluminum forming temperature (up to 430°C), thus allowing temperature effects to be studied. Numerical improvements permit the analysis at high extrusion ratios. The flow function has been redefined to permit the study of variable density material. 6 refs., 8 figs., 1 tab.

19874 Non-Ising behavior of the Pt(110) surface phase transition. Robinson, I.K. (AT&T Bell Laboratories, Murray Hill, New Jersey 07974 (US)— Institut fuer Grenzflachenforschung und Vakuumphysik, Kernsforschungsanlage Juelich, Postfach 1913, D-5170 Juelich, West Germany); Vlieg, E.; Kern, K. *Physical Review Letters (USA),* 63(23): 2578-2581 (4 Dec 1989).

We have investigated the structural transition of the Pt(110)1×2 reconstruction using x-ray diffraction. We find weakening and broadening of the half-order peak with temperature above T_c=1080 K, exactly analogous to the Au(110)1×2 surface studied by LEED. Unlike the Au(110) result, however, we find the peak shifts as well, indicating that steps spontaneously appear in Pt(110) above T_c. Even though we find good agreement with theoretical 2D Ising exponents, the steps refute classification of this system as a simple two-state model, and favor a roughening description instead.

19875 Mechanical stability and charge densities near stacking faults. MacLaren, J.M. (Theoretical Division, Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (US)— The Blackett Laboratgory, Imperial College, London SW7 2BZ, United Kingdom— Materials Science and Technology Division, Los Alamos National Laboratory, *Physical Review Letters (USA),* 63(23): 2586-2589 (4 Dec 1989).

The electronic structure near (111) twin stacking faults in Cu, Ir, and Al is investigated with the recently developed layer Koringa-Kohn-Rostoker method. The calculated stacking-fault energies are 341 mJ/m^2 (Ir), 118 mJ/m^2 (Al), and 58 mJ/m^2 (Cu), in excellent agreement with experiment. These trends are discussed in terms of changes in local bonding and symmetry at the stacking fault.

19876 Biaxial elastic modulus of metallic films determined from vibrating circular membranes. Fartash, A. (Physics Department, B-019, University of California, San Diego, La Jolla, California 92093 (USA)); Schuller, I.K.; Grimsditch, M. *Applied Physics Letters (USA),* 55(25): 2614-2616 (18 Dec 1989). DOE Contract W-31-109-ENG-38.

The biaxial moduli of free-standing metallic films have been determined from their behavior as elastically tensioned membranes. Errors due to thickness determination and warping of the films are eliminated, thereby opening up the possibility of solving a number of controversial issues. The method combines the determination of stress from the frequency of the membrane modes with optical measurements of strain. Tests on Ta and Ni films yield values of the biaxial modulus in good agreement with calculated literature data.

19877 Quantitative description of a high J_c Nb-Ti superconductor during its final optimization strain. I. Microstructure, T_c, H_{c2}, and resistivity. Meingast, C. (Applied Superconductivity Center, University of Wisconsin-Madison, Madison, Wisconsin 53706 (US)); Lee, P.J.; Larbalestier, D.C. *Journal of Applied Physics (USA),* 66(12): 5962-5970 (15 Dec 1989).

A most important step in the critical current density (J_c) optimization of Nb-Ti is the large final drawing strain, in which α-Ti precipitates, initially approximately equiaxed and 100–200 nm in diameter, are drawn into ribbons, whose thickness (1–2 nm) is less than the superconducting coherence length [ξ (4.2 K)~5 nm]. Using transmission electron microscopy, the precipitate thickness, spacing, cross-sectional area, and circumference were measured over the whole final drawing strain range. Each of these parameters was found to have a simple power dependence on the wire diameter. T_c, H_{c2}, and the resistivity (ρ_n) were also change considerably during the refinement of the precipitates. Directly after precipitation, T_c increased, and $(dH_{c2}/dT)_{T_c}$ and ρ_n were reduced from the single-phase values. Drawing the wire returned these parameters to their single-phase values, as the precipitate thickness

was reduced to less than ξ. This observation explains a long-standing peculiarity in this system, namely that the optimum H_{c2} of high J_c conductors occurs for a composition close to Nb 46 wt.% Ti, even when the precipitation of 18 vol % of α-Ti shifts the matrix composition to a Nb-rich composition of theoretically lower H_{c2}.

19878 Quantitative description of a very high critical current density Nb-Ti superconductor during its final optimization strain. II. Flux pinning mechanisms. Meingast, C. (Applied Superconductivity Center, University of Wisconsin-Madison, Madison, Wisconsin 53706 (US)); Larbalestier, D.C. *Journal of Applied Physics (USA)*, 66(12): 5971-5983 (15 Dec 1989).

Flux pinning by α-Ti precipitates has been studied in a carefully made Nb 48 wt. % Ti composite having very high critical current density and a macroscopically rather uniform precipitate array. The pinning was studied as a function of field (0–15 T) and temperature (2.3 K—T_c) for a ratio of the precipitate thickness (t_{ppt}) and the coherence length (ξ) which was varied between 10 and 0.1 by a large drawing strain. Surprisingly, the maximum bulk pinning force (F_p) occurred for $t_{ppt}/2\xi \simeq 0.1$ and a precipitate spacing about one-eighth the fluxon spacing, suggesting that the flux pinning occurs at clusters of precipitates. In contrast to earlier studies, strict temperature scaling of F_p was not observed; the peak of the pinning force shifted to lower reduced fields as the temperature increased. The effect was largest for the finest scale microstructure. This non-scaling is interpreted in terms of two pinning mechanisms having different field and temperature dependencies. At low reduced fields, and at temperatures close to T_c, the core interaction (δH_c) dominates. At higher reduced fields and low reduced temperatures, pinning due to variations in κ also contributes to F_p. Clusters of very fine α-Ti ribbon precipitates give rise to these variations in H_c and κ. A comparison of the specific pinning force with the core interaction model was made close to T_c, where the δH_c pinning mechanism dominates. Good agreement was obtained for all precipitate thicknesses, indicating that the pinning can be quantitatively described by the core interaction and the direct summation models.

19879 Novel metal-film configuration: Rh on Ag(100). Schmitz, P.J. (Department of Chemistry and Ames Laboratory, Iowa State University, Ames, Iowa 50011 (US)); Leung, W.; Graham, G.W.; Thiel, P.A. *Physical Review [Section] B: Condensed Matter (USA)*, 40(17): 11477-11487 (15 Dec 1989). DOE Contract W-7405-ENG-82.

We present the results of an investigation of Rh films on Ag(100). The films are studied using Auger-electron spectroscopy, low-energy electron diffraction, x-ray photoelectron spectroscopy, ultraviolet photoemission spectroscopy, ion-scattering spectroscopy, and scanning Auger microscopy. Overlayer characteristics are examined at substrate temperatures of 300 and 600 K. We find that the equilibrium configuration is not predicted by any of the three traditional growth modes (Frank–Van der Merwe, Stranski-Krastanov, or Volmer-Weber). Rather, the equilibrium film structure is that of a Ag-Rh-Ag sandwich, most probably flat. Formation of the sandwich is thermodynamically driven by the difference in surface free energies between Ag and Rh, and is kinetically accessible because of the high mobility of the Ag atoms.

19880 Low-temperature behavior of Ni_3Al alloys near the spin-fluctuator–ferromagnet phase boundary. Dhar, S.K. (Ames Laboratory, Departments of Materials Science and Engineering and of Physics, Iowa State University, Ames, Iowa 50011 (US)); Gschneidner, K.A. Jr.; Miller, L.L.; Johnston, D.C. *Physical Review [Section] B: Condensed Matter (USA)*, 40(17): 11488-11492 (15 Dec 1989). DOE Contract W-7405-ENG-82.

The heat capacity C of two alloys of the composition $Ni_{73.75}Al_{26.25}$ (alloy IV) and $Ni_{76.41}Al_{23.59}$ (alloy V) has been measured in the temperature range 1.5–20 K. Magnetization as a function of temperature and applied magnetic field has also been studied for these two alloys and three other alloys (alloys I, II, and III: $Ni_{74.75}Al_{25.25}$, $Ni_{75.00}Al_{25.00}$, and $Ni_{75.60}Al_{24.40}$, respectively) which had been studied calorimetrically earlier [Phys. Rev. B 39, 7453 (1989)]. The C/T versus T^2 plot of alloy V is linear in the range 1.5–12 K but a barely discernible upturn exists for alloy IV below about 6 K. From Arrott plots magnetic ordering temperatures of 38.2 and 68.9 K, and spontaneous moments of 0.076 and 0.114 μ_B/Ni at 5 K were obtained for alloys III and V, respectively. Alloys I, II, and IV, however, are paramagnetic down to at least 5 K. The Curie temperatures of the ordered alloys III and V, when determined and compared with previous results published in the literature, show a composition shift between our chemically analyzed samples and those measured on nominal composition alloys. The difference is thought to be due to a loss of aluminum by vaporization during the sample preparation. These results, taken together with our earlier results, show that for some compositions the upturn in the C/T plots of well prepared "Ni_3Al" alloys, which have a solid solution range from 72.5 to 77 at. % Ni, is due to spin fluctuations and not due to magnetic clusters. Furthermore, our results show, for the first time, that the electronic specific-heat constant and the upturn approach a maximum as the composition approaches the spin-fluctuator–ferromagnetic crossover point (75.1 at. % Ni) from either side in accord with theory.

19881 Calculation of grain-boundary segregation in Ni-Cu alloys. Foiles, S.M. (Theoretical Division, Sandia National Laboratories, Livermore, California 94551-0969 (US)). *Physical Review [Section] B: Condensed Matter (USA)*, 40(17): 11502-11506 (15 Dec 1989).

The equilibrium segregation at symmetric twist grain boundaries in Ni-Cu alloys is computed with use of Monte Carlo simulations combined with the Daw-Baskes embedded-atom method. These simulations include both compositional rearrangements and atomic displacements. The boundaries studied are the $\Sigma 5$, $\Sigma 13$, and $\Sigma 61$ [001] symmetric twist boundaries. It is found that Cu segregates to the boundary and that the change in composition is confined to a few atomic layers near the boundary. The degree of segregation was found to be greater for Ni-rich alloys and for large-angle boundaries. The variation of the concentration within the planes parallel to the boundary for a low-angle twist boundary is studied and the variations correlated with the positions of the boundary dislocations.

19882 Optical reflectance of liquid mercury. Tuminello, P.S. (Health and Safety Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831-6123 (USA)); Arakawa, E.T.; Inagaki, T.; Parks, J.E. II. *Physical Review [Section] B: Condensed Matter (USA)*, 40(17): 11994-11996 (15 Dec 1989). DOE Contract AC05-84OR21400.

Normal-incidence and grazing-incidence reflectances of liquid Hg have been measured in the visible region at room temperature (24 °C). The results were consistent with the optical properties determined by ellipsometry. No evidence was found for transition layers on the surface of liquid Hg.

19883 Measurement of intergranular attack in stainless steel using ultrasonic energy. Mott, G.; Attaar, M.; Rishel, R.D. To Dept. of Energy, Washington, DC. USA Patent 4,854,173. 8 Aug 1989. Filed date 2 Mar 1988. USA Patent Application 7 163,360. Int. Cl. G01N 29/04. 8p. Available from Patent and Trademark Office, Box 9, Washington, DC 20232.

This patent describes ultrasonic test methods used to measure the depth of intergranular attack (IGA) in a stainless steel specimen. The ultrasonic test methods include a pitch-catch surface wave technique and a through-wall pulse-echo technique. When used in combination, these techniques can establish the extent of IGA on both the front and back surfaces of a stainless steel specimen from measurements made on only one surface.

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Refer also to citation(s) 19734, 19740, 19741, 19834, 19848, 19853, 19868, 20133, 20136, 20797, 20816, 20819, 20828, 20830, 20832

19884 (AD-A–214030/9/XAB) **Bulk-wave characterization of high-T(c) superconductors. Annual report, 1 November 1988-1 November 1989.** Levy, M.; Sarma, B. Wisconsin Univ., Milwaukee, WI (USA). Dept. of Physics. 1 Nov 1989. 11p. Available from NTIS, PC A03/MF A01.

The objective of this research is to characterize high-T(c) superconductors with ultrasonic waves. A peak in ultrasonic attenuation has been observed at the superconducting phase transition of the

thallium superconducting compound with a T(c) = 103 K. The position of this peak is independent of frequency and therefore should not be produced by a relaxation mechanism. It may be produced by interactions with fluctuations associated with the superconducting phase transition. The magnitude of the peak decreases in magnetic fields up to 6 Tesla. This appears to be the first time that an attenuation effect has been observed which is directly associated with the superconducting state of a high-T(c) superconductor. Shear waves propagating parallel to the Copper Oxide planes and polarized in the CuO planes of a sinter forged $YBa_2Cu_3O_7$ sample exhibit only one maximum in attenuation at around 180 K. Velocity measurements in the copper free high-T(c) superconductors Ba(1-x)K(x)BiO_3 show a definite change in slope at the phase transition. Measurements in the heavy fermion superconductor UPt(3) show a 40 ppm change in velocity around 4.5 K, its antiferromagnetic phase transition temperature.

19885 (AD-A-214347/7/XAB) **Structural, magnetic and electrical properties of La(2-x)Ba(x)NiO4.** Austin, A.B.; Carreiro, L.G.; Marzik, J.V. Army Materials Research Agency, Watertown, MA (USA). Materials Technology Lab. 1989. 16p. (MTL-TR–89-79). Available from NTIS, PC A03/MF A01.

Pub. in Materials Research Bulletin, Vol. 24, 639-646(1989).

Polycrystalline samples of the composition $La_{2-x}Ba_xNiO4$ were prepared by standard solid-state-chemistry techniques. The samples were characterized by X-ray diffraction, magnetic susceptibility in the temperature range 6 to 300 K, and room-temperature electrical resistivity. The effect of barium substitution on the structural, magnetic, and electrical properties is reported.

19886 (AECL–9381) **Development of advanced ceramics at AECL.** Palmer, B.J.F. (Atomic Energy of Canada Ltd., Chalk River, ON (Canada). Chalk River Nuclear Labs.); MacEwen, S.R.; Sawicka, B.D.; Hayward, P.J.; Sridhar, S. Atomic Energy of Canada Ltd., Chalk River, ON (Canada). Chalk River Nuclear Labs. Dec 1986. 22p. (CONF-8611301–: 2. workshop of the Canadian-University Council on advanced Ceramics, Toronto (Canada), 4 Nov 1986). Order Number DE90617454. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Atomic Energy of Canada Limited (AECL) has a long history of developing ceramics for nuclear fission and fusion applications. AECL is now applying its multidisciplinary materials R and D capabilities, including unique capabilities in ceramic processing and nondestructive evaluation, to develop advanced ceramic materials for commercial and industrial applications. This report provides an overview of the facilities and programs associated with the development of advanced ceramics at AECL.

19887 (BNL–43358) **Sol-gel derived polytitanosiloxane coatings.** Sugama, Toshifumi. Brookhaven National Lab., Upton, NY (USA). Sep 1989. 21p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research. DOE Contract AC02-76CH00016. MIPR-ARO-102-89. (CONF-900403–4: Corrosion '90, Las Vegas, NV (USA), 23-27 Apr 1990). Order Number DE90004186. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Amorphous polytitanosiloxane (PTS) was formed by hydrolysis-polycondensation and hydrolysis-polycondensation-pyrolysis reaction of precursor sol solutions consisting of monomeric organosilanes, $Ti(OC_2H_5)_4$, methanol, water and hydrochloric acid, over the temperature range 100° to 500°C. These reaction processes which are responsible for the assemblage of PTS networks were found to depend mainly on the species of organosilane used. The PTS was applied as a coating on aluminum substrates, and the factors which play an important role in providing corrosion protection were investigated. Three major findings are as follows: (1) the addition of HCl, which was used as hydrolysis accelerator for the organosilanes and $Ti(OC_2H_5)_4$, acts to produce a clear sol solution, thereby aiding in the formation of smooth and uniform coating layers, (2) the organosilane to $Ti(OC_2H_5)_4$ ratios are critical for the fabrication of PTS films, and (3) moderate densifications of the Si-O-Ti bond in PTS networks are needed to produce a good film.

19888 (CONF-891119–99) **Microstructural characterization of multiphase coatings produced by chemical vapor deposition.** Lowden, R.A.; More, K.L.; Besmann, T.M.; James, R.D. Oak Ridge National Lab., TN (USA). [1989]. 7p. Sponsored by U.S. Department of Defense. DOE Contract AC05-84OR21400. Contract AFWAL MIPR FY1457-89-N5001. From Materials Research Society fall meeting; Boston, MA (USA); 27 Nov - 2 dec 1989. Order Number DE90007573. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Chemical vapor deposition has been utilized to produce ternary, multiphase coatings of various compositions of silicon carbide (SiC) with Ti, Cr, and Mo. Thermodynamic calculations have been performed for a variety of experimental conditions in each system. Scanning, transmission and analytical electron microscopy, and x-ray diffraction techniques have been used to characterize the microstructures and to determine compositions. 16 refs., 5 figs.

19889 (CONF-891119–101) **Light-scattering measurements of CVD [chemical vapor deposition] silicon carbide.** Sheldon, B..; Besmann, T.M. Oak Ridge National Lab., TN (USA). [1989]. 8p. Sponsored by U.S. Department of Defense. DOE Contract AC05-84OR21400. From Materials Research Society fall meeting; Boston, MA (USA); 27 Nov - 2 dec 1989. Order Number DE90007885. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Surface morphologies created by the chemical vapor deposition (CVD) of silicon carbide were examined with light scattering. Silicon carbide was deposited from methyltrichlorosilane under various conditions to create different surfaces. A helium neon laser was used, and the scattered light was measured over a range of scattering angles. These measurements are compared with scanning electron microscopy (SEM) observations and profilometer measurements of the same surfaces. In theory that scattered light contains all of the information needed to provide a statistical description of a given surface; however, a complete vector theory for the scattering phenomena is too complex to provide any simple basis for experimental analysis. The application and limits of existing descriptions of scattering from a rough surface are discussed. 8 refs., 9 figs.

19890 (CONF-900160–3) **Microstructural characterization of silicon nitride ceramics processed by pressureless sintering, overpressure sintering, and sinter/HIP.** Selkregg, K.R. (Oak Ridge National Lab., TN (USA)); More, K.L.; Seshadri, S.G.; McMurtry, C.H. Oak Ridge National Lab., TN (USA). [1990]. 17p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. From 14. annual conference on composites and advanced ceramics; Cocoa Beach, FL (USA); 14-17 Jan 1990. Order Number DE90007126. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Silicon nitride ceramics of the same nominal sialon composition have been sintered under different conditions including atmospheric sintering, overpressure sintering, reaction bonded (nitrided pressureless sinter) and sinter/HIP cycles. The sintered ceramics, which exhibited dramatic differences in fracture toughness, have been characterized by x-ray diffraction, scanning electron microscopy, analytical transmission electron microscopy, and image analysis techniques. Fracture toughness data have been correlated to the microstructural and chemical analysis of the grain boundary phases. The microstructure was the strongest influencing factor on the observed fracture toughness difference. 5 refs., 5 tabs.

19891 (CONF-900393–1) **The design of advanced ceramic composites.** Becher, P.F. Oak Ridge National Lab., TN (USA). [1990]. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From International forum on fine ceramics '90; Nagoya (Japan); 12-16 Mar 1990. Order Number DE90006613. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Ceramics with improved fracture resistance are achieved by incorporation of brittle reinforcing phases and phases which exhibit a stress-induced martensitic transformation and by tailoring the matrix microstructure. The optimization of the toughening effects due to each mechanism must rely on knowledge of microstructural and compositional factors. Recent advances in toughening models are used as a basis for designing these systems. 20 refs., 3 figs.

19892 (CONF-900414–1) **Laser surface interactions of high-T_c superconductors.** Chen, C.H.; McCann, M.P.; Phillips, R.C. Oak Ridge National Lab., TN (USA). Jan 1990. 8p.

Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Advances in material science and applications of high temperature superconductors; Greenbelt, MD (USA); 2-6 Apr 1990. Order Number DE90006894. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

During the past two years, one of the most exciting research fields in science has been the study of the newly discovered high-$T_c$metal oxide superconductors. Although many theoretical models were proposed, there has been no general agreement on any theory to explain these materials. One of the "peculiar" features of these high-$T_c$materials is the noninteger number of oxygen atoms. The oxygen content is extremely critical to the superconductive properties. Our results from mass spectroscopy of laser desorbed species indicate that significant quantities of oxygen molecules are trapped in the bulk of these superconductors. It appears that these trapped oxygen molecules may play key roles in superconductive properties. 23 refs., 4 figs., 1 tab.

19893 (CONF-8910248–2) **Identification and development of optimum SiC whiskers for silicon nitride matrix composites.** Tiegs, T.; Allard, L.F.; Becher, P.F.; Ferber, M.F. Oak Ridge National Lab., TN (USA). [1989]. 27p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. From Annual automotive technology development contractors coordination meeting; Dearborn, MI (USA); 23-26 Oct 1989. Order Number DE90006888. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Using micromechanics modeling and observed increases in fracture toughness for whisker-reinforced alumina and silicon nitride, SiC whisker strengths were calculated. Based on those results, flaw sizes were estimated and compared to scanning and transmission electron microscopy observations of the structure in typical whiskers. The sizes of the strength-limiting flaws were calculated to be in the range of 0.1 and 0.4 μm, which corresponds to the size of defects observed in many of the current commercial whiskers. Defects identified in this size range include the core regions, which are accumulations of smaller inclusions as well as voids located within some whisker types. Another defect that decreases whisker strength is excessive surface roughness (usually associated with crystallographic phase changes) that results in stress concentrations. Calculations indicate that if high-strength SiC whiskers were made available by eliminating strength-limiting flaws, silicon nitride composites with toughnesses (K_{IC}) >15 MPa(m)$^{1/2}$ may be realized. 23 refs., 6 figs., 3 tabs.

19894 (CONF-8910248–6) **Synthesis of high-purity sinterable silicon nitride powder.** Crosbie, G.M. (Ford Motor Co., Dearborn, MI (USA)); Predmesky, R.L.; Nicholson, J.M. Oak Ridge National Lab., TN (USA). [1989]. 7p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. From Annual automotive technology development contractors coordination meeting; Dearborn, MI (USA); 23-26 Oct 1989. Order Number DE90007050. Available from NTIS, PC A02/MF A01 - OSTI.

A process is under development for the synthesis of silicon nitride powders to meet the special needs for vehicular applications, as part of the Ceramic Technology for Advanced Heat Engines (CTAHE) program. The process study is directed toward a modification of the low temperature reaction of $SiCl_4$ with liquid NH_3 which is characterized (1) by absence of organics (a source of carbon contamination) and (2) by pressurization (for improved by-product extraction efficiency). This year, the first vapor-chloride-liquid ammonia runs were made with the prepilot equipment. Equi-axed microstructures were obtained which were similar to those of the 1986 lab demonstration phase product. By use of a revised saturator-mixer design, the vapor inlet stayed clear through multiple runs. Through improvements to the agitator seal and infrared handling, the intermediate product of the vapor reaction with liquid ammonia was shown to be the same imide as obtained by Billy, et al. (1975). Thermal decomposition led to a nitride without the Si_2N_2O phase previously seen. A pressureless sintered density of 88% of theoretical was obtained. 8 refs., 8 figs., 1 tab.

19895 (CONF-8910350–1) **Neutron scattering measurements of the magnetic excitations of high-temperature superconducting materials.** Mook, H.A. (Oak Ridge National Lab., TN (USA)); Aeppli, G.; Hayden, S.M.; Fisk, Z.; Rytz, D. Oak Ridge National Lab., TN (USA). [1989]. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From NATO advanced research workshop on dynamics of magnetic fluctuations in high temperature superconductors; Crete (Greece); 10-14 Oct 1989. Order Number DE90006567. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Since the discovery of superconductivity in $(La_{1-x}Ba_x)_2CuO_4$ by Bednorz and Mueller in 1986, there has been an enormous interest in all aspects of this family of materials. Our measurements have used neutron scattering techniques to study the magnetic properties of these materials. The measurements were made at the Institut Laue-Langevin in Grenoble, France, and at the Risoe National Laboratory at Roskilde, Denmark. A number of studies of these types of materials have previously been made at other laboratories, particularly Brookhaven National Laboratory. Many of our measurements have been made on a different energy scale than the earlier measurements, and different aspects of the problem have been addressed. Where the experiments have overlapped, good agreement has generally been found. We have chosen to address the problem by first using high-energy neutrons so that the fundamental properties of the excitations such as the spin wave velocity and lifetimes can be isolated. We then used lower energy neutrons to cover a wide energy scale. Indeed, particularly for La_2CuO_4, we have used incident neutrons varying in energy from 0.3 eV to 4 meV. This required experiments on a number of different neutron spectrometers. 12 refs., 9 figs.

19896 (DOE/ER/45113–5) **Superconducting materials: Performance report, September 1, 1989–August 31, 1990.** Ruvalds, J. Virginia Univ., Charlottesville, VA (USA). Dept. of Physics. 1990. 28p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-84ER45113. Order Number DE90007419. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Our research on high temperature superconductors has recently produced novel insights for the normal state properties of the copper oxides that have been discovered in the last few years. Advances in materials preparation have produced single crystal samples, and sophisticated surface cleavage techniques have unveiled truly metallic behavior in many respects. Thus, the very recent discovery of a Fermi surface in several cuprate superconductors by photoemission spectroscopy has aroused interest in several experimental features which heretofore were in apparent contrast to the expectations for a conventional Fermi Liquid. Hall coefficient measurements revealed mysterious variations as a function of chemical composition and temperature which are difficult to interpret in terms of a single group of carriers such as a small number of holes. We have shown that the mobility of electrons in a nearly half-filled band is very low in the presence of strong electron-electron coupling, and the associated scattering cross section is very sensitive to the alloy composition. We have shown that Fermi surface nesting in conjunction with on-site Coulomb coupling U of intermediate strength, i.e., U comparable to the electric bandwidth W, yields remarkable modifications of the electronic susceptibility χ and the quasiparticle damping Γ. Finally, we report the calculated plasmon spectrum of $YBa_2Cu_3O_{7-\delta}$ as a function of the oxygen content δ. These results reveal a lower energy acoustic plasmon branch that exists over a wide region of momentum only in cases corresponding to superconducting phases. The first direct evidence for an electronic excitation near 45 MeV has just been discovered at IBM with high resolution electron loss spectroscopy. 5 figs.

19897 (DOE/ER/45325–3) **Diffraction studies of the structure of glasses and liquids: Technical progress report.** Moss, S.C. Houston Univ., TX (USA). [1989]. 31p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-87ER45325. Order Number DE90007662. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

At the University of Houston, our program on glasses and liquids has continued with emphasis on melanin; vitreous TiO_2; metallic glasses/quasicrystals, including the computer modelling of quasicrystals via icosahedral glass models; and the structure of C^+ ion-beam deposited carbon films. The development of a dedicated glass and liquid diffractometer (GLAD) at the Argonne IPNS, under

the direction of Dr. David L. Price, has entered the prototype stage. We are now quite close to a fully operating facility and commissioning should take place in the Spring 1990 with beam time available for participating scientists, on state-of-the-art experiments, shortly thereafter.

19898 (DOE/ER/45356–3) **Investigation of the processes controlling the flame generation of refractory materials: Progress report, July 1, 1989–June 30, 1990.** Katz, J.L. Johns Hopkins Univ., Baltimore, MD (USA). Jan 1990. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-88ER45356. Order Number DE90007564. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We are studying the processes involved in the formation of refractory material powders using the counterflow diffusion flame burner. Understanding refractory particle generation processes requires measurement of the concentrations of the reactive species, the temperature, and particle nucleation, growth, and agglomeration, all as a function of their spatial distributions. Optical techniques are valuable for obtaining this information since they are species specific, provide good spatial and temporal resolution, and are essentially non-intrusive. During the past year several significant improvements in our optical measurement techniques have been made. 7 figs.

19899 (HEDL-SA–3244) **Electro-spark deposition: A technique for producing wear resistant coatings.** Sheldon, G.L. (Washington State Univ., Pullman, WA (USA)); Johnson, R.N. Hanford Engineering Development Lab., Richland, WA (USA). Dec 1984. 9p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76FF02170. (CONF-850415–10: 4. international conference on wear of materials, Vancouver (Canada), 14-18 Apr 1985). Order Number DE90007244. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Electro-spark deposition (ESD) is a coating process using short duration, high current electrical pulses to deposit an electrode material on a metallic substrate. A principal attribute of the process is its ability to apply metallurgically bonded coatings with such a low total heat input that the bulk substrate material remains at or near ambient temperatures. A review of the process is briefly given, then current research using WC-TiC and Cr_3C_2 electrodes to deposit coatings on Type 316 stainless steel and other substrates is presented. The ESD carbide coatings were found to be exceptionally hard, wear-resistant and spalling-resistant in high-stress rubbing tests. Several applications for nuclear reactor components are described. 17 refs., 18 figs., 1 tab.

19900 (LA-UR–90-112) **Copper and oxygen NMR studies on the magnetic properties of $YBa_2Cu_3O_{7-y}$.** Takigawa, Masashi. Los Alamos National Lab., NM (USA). [1989]. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-8910350–2: NATO advanced research workshop on dynamics of magnetic fluctuations in high temperature superconductors, Crete (Greece), 10-14 Oct 1989). Order Number DE90007889. Available from NTIS, PC A03/MF A01 - OSTI.

Microscopic magnetic properties of the CuO_2 layers in $YBa_2Cu_3O_{7-y}$ have been investigated from Cu and O NMR experiments on the $y\simeq0$ (T_c=92K) and y=0.37 (T_c=62K) materials. The Knight shift at the planar Cu and the planar oxygen sites are found to be proportional to a common spin susceptibility χ_s which depends on temperature and oxygen-content, strongly supporting a single component spin model for the CuO_2 planes. In the y=0.37 material, χ_s shows a significant reduction with decreasing temperature in the normal state. The nuclear relaxation rate ($1/T_1$) in the $y\simeq0$ material, particularly different behaviors at Cu and O sites, can be accounted for by the hyperfine coupling of Cu and O nuclei to an antiferromagnetically correlated single spin system. Quite different behaviors of $1/T_1$ were observed in the y=0.37 material, which might be due to combined effects of antiferromagnetic correlations and a temperature-dependent spin susceptibility. 38 refs., 7 figs.

19901 (LBL–28305) **Thermal and magnetic measurements on $YBa_2Cu_3O_{7-y}$.** Gordon, J.E.; Fisher, R.A.; Kim, S.; Phillips, N.E. Lawrence Berkeley Lab., CA (USA). Jan 1990. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-900133–1: International conference on superconductivity, Bangalore (India), 10-14 Jan 1990). Order Number DE90007075. Available from NTIS, PC A02/MF A01 - OSTI.

Specific heat measurements in zero and 7T magnetic fields from 0.4 to 100K, and magnetic susceptibility measurements above $T_c$have been made on a series of polycrystalline samples of $YBa_2Cu_3O_{7-y}$ (YBCO). These measurements reveal a number of regularities. The size of $\Delta C(T_c)/T_c$for the samples [$\Delta C(T_c)$ is the jump in the specific heat at T_c] appears to vary linearly with the low temperature value of the Debye θ, with the entropy change between $\approx$ 85K and $T_c$induced by the application of a 7T magnetic field, and with the variation of the observed low temperature with magnetic field, and with the variation of the observed low temperature γ with magnetic field, $d\gamma/dH$. On the other hand the temperature-independent part of the magnetic susceptibility above $T_c$appears to be essentially independent of $\Delta C(T_c)/T_c$. These results are consistent with the idea that samples of YBCO below $T_c$are a mixture of superconductivity and normal phases. 6 refs., 2 figs.

19902 (N–90-11807) **Static tensile and tensile creep testing of four boron nitride coated ceramic fibers at elevated temperatures. Final report.** Coguill, S.L.; Adams, D.F.; Zimmerman, R.S. Wyoming Univ., Laramie, WY (USA). Aug 1989. 135p. (NASA-CR–184999;NAS–1.26:184999;UW-CMRG-R–89-123). Available from NTIS, PC A07/MF A01.

Six types of uncoated ceramic fibers were static tensile and tensile creep tested at various elevated temperatures. Three types of boron nitride coated fibers were also tested. Room temperature static tensile tests were initially performed on all fibers, at gage lengths of 1, 2, and 4 inches, to determine the magnitude of end effects from the gripping system used. Tests at one elevated temperature, at gage lengths of 8 and 10 inches, were also conducted, to determine end effects at elevated temperatures. Fiber cross sectional shapes and areas were determined using scanning electron microscopy. Creep testing was typically performed for 4 hours, in an air atmosphere.

19903 (N–90-11881) **Fundamental tribological properties of ion-beam-deposited boron nitride films.** Miyoshi, K. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Oct 1989. 25p. (NASA-TM–102088;E–4850;NAS–1.15:102088). Available from NTIS, PC A03/MF A01.

The adhesion, friction, and micromechanical properties of ion-beam-deposited boron nitride (BN) films are reviewed. The BN films are examined in contact with BN metals and other harder materials. For simplicity of discussion, the tribological properties of concern in the processes are separated into two parts. First, the pull-off force (adhesion) and the shear force required to break the interfacial junctions between contacting surfaces are discussed. The effects of surface films, hardness of metals, and temperature on tribological response with respect to adhesion and friction are considered. The second part deals with the abrasion of the BN films. Elastic, plastic, and fracture behavior of the BN films in solid-state contact are discussed. The scratch technique of determining the critical load needed to fracture interfacial adhesive bonds of BN films deposited on substrates is also addressed.

19904 (N–90-11902) **Advances and directions of ion nitriding/carburizing.** Spalvins, T. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Sep 1989. 6p. (NASA-TM–102398;E–5148;NAS–1.15:102398;CONF-8909302–: 2. international ion nitriding/carburizing conference, Cincinnati, OH (USA), 18-20 Sep 1989). Available from NTIS, PC A02/MF A01.

Ion nitriding and carburizing are plasma activated thermodynamic processes for the production of case hardened surface layers not only for ferrous materials, but also for an increasing number of nonferrous metals. When the treatment variables are properly controlled, the use of nitrogenous or carbonaceous glow discharge medium offers great flexibility in tailoring surface/near-surface properties independently of the bulk properties. The ion nitriding process has reached a high level of maturity and has gained wide industrial acceptance, while the more recently introduced ion carburizing process is rapidly gaining industrial acceptance. The current status of plasma mass transfer mechanisms into the surface regarding the formation of compound and diffusion layers in

ion nitriding and carbon build-up ion carburizing is reviewed. In addition, the recent developments in design and construction of advanced equipment for obtaining optimized and controlled case/core properties is summarized. Also, new developments and trends such as duplex plasma treatments and alternatives to dc diode nitriding are highlighted.

19905 (ORNL/TM–11418) **High Temperature Materials Laboratory second annual report (October 1988 through September 1989).** Tennery, V.J.; Foust, F.M. Oak Ridge National Lab., TN (USA). Dec 1989. 49p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. Order Number DE90005820. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The High Temperature Materials Laboratory has completed its second year of operation as a designated DOE User Facility at the Oak Ridge National Laboratory. Growth of the user program is evidenced by the number of outside institutions which have executed user agreements since the facility began operation in 1987. Thirty-four institutions (11 universities, 20 industries, and 3 other government facilities) were added in FY 1989; there are now a total of 64 agreements in effect. Forty-seven nonproprietary research proposals (22 each from universities and industries and 3 other government facilities) and 3 proprietary proposals were approved during this period. The total approved proposals to date is 100. Research projects active in FY 1989 are summarized.

19906 High temperature superconducting compounds: Processing and related properties. Whang, S.H. (Polytechnic Univ., Dept. of Metallurgy and Mat. Science, Brooklyn, NY (US)); DasGupta, A. 693p. The Metallurgical Society Inc., Warrendale, PA (1989). (CONF-8902140–: High temperature superconducting compounds: processing and related properties, Las Vegas, NV (USA), 27-28 Feb 1989).

This book contains 57 papers on processing of high temperature superconductors. Topics covered include: Fabrication of high T_c superconductor wires; Electric conduction and microchemistry of high T_c superconducting cuprates; and Role of grain boundaries in high T_c superconductors.

19907 Recent improvements in bulk properties of ceramic superconductors. Poeppel, R.B. (Argonne National Lab., Argonne, IL (US)); Balachandran, U.; Bloom, I.; Dorris, S.E.; Dusek, J.T.; Goretta, K.C.; Lanagan, M.T.; Leu, H.J.; Maroni, V.A.; Picciolo, J.J. pp. 693 of High temperature superconducting compounds: Processing and related properties. Whang, S.H.; DasGupta, A. The Metallurgical Society Inc., Warrendale, PA (1989). DOE Contract W-31-109-ENG-38. (CONF-8902140–: High temperature superconducting compounds: processing and related properties, Las Vegas, NV (USA), 27-28 Feb 1989).

Ceramic superconductors are being considered for uses ranging from large-scale applications such as the generation, transmission, and storage of electricity to small-scale applications such as electronic circuitry. These applications require that the electrical, mechanical, and chemical properties of superconductors meet certain specifications. The properties of superconductors are strongly influenced by each step of the processing procedure, which includes powder processing to form the superconductor powder, shape forming to produce bulk superconductors in convenient shapes, and finally an appropriate heat treatment to yield good superconducting properties. In this paper, the processing procedures for Y-Ba-Cu-O, Bi-Sr-Ca-Cu-O, Tl-Ca-Ba-Cu-O are reviewed. Improvements in the processing procedures, and the resulting improvements in the mechanical and electrical properties are discussed. In addition, several fabrication techniques are described which have produced bulk conductors having critical current densities approaching those of thin films.

19908 Two dimensional quantum spin fluid: Progenitor of high temperature superconductivity. . Endoh, Y. (Dept. of Physics, Tohoku Univ., Sendai 980 (JP)); Yamada, K.; Birgeneau, R.J.; Gabee, D.R.; Jenssen, H.P.; Picone, P.J.; Thurston, T.R.; Shirane, G.; Hidaka, Y.; Murakami, T. pp. 341 of Mechanisms of high temperature superconductivity. Kamimura, H.; Oshiyama, A Springer-Verlag New York Inc., New York, NY (1989). (CONF-8810437–: Mechanisms of high temperature superconductivity, Hakone (Japan), 24-27 Oct 1988).

Neutron scattering probed novel two dimensional antiferromagnetic spin correlations in pure La_2CuO_4 which is the mother compound of high temperature superconductors of doped $La_{2-x}M_xCuo_4$. Cu^{2+} moments are ordered instantaneously over very large areas in the CuO_2 plane but there is no measurable time averaged staggered moment. Since the dynamical behavior observed is similar to that in the quantum antiferromagnetic chain, the authors conclude that spin fluctuations observed at finite temperatures are quantum spin liquid state, like that in quantum antiferromagnetic chain at T = O.

19909 Microstructures and intragrain critical current densities in $YBa_2(Cu_{1-x}M_x)_3O_7$. Xu, Y. (Dept. of Applied Science, Brookhaven National Lab., Upton, NY (USA)); Zhu, Y.; Moodenbaugh, A.R.; Suenaga, M. pp. 693 of High temperature superconducting compounds: Processing and related properties. Whang, S.H.; DasGupta, A. The Metallurgical Society Inc., Warrendale, PA (1989). DOE Contract AC02-76CH00016. (CONF-8902140–: High temperature superconducting compounds: processing and related properties, Las Vegas, NV (USA), 27-28 Feb 1989).

The authors discuss their study of microstructural characterization performed on $YBa_2(Cu_{1-x}M_x)_3O_{7-\delta}$ where M=Al, Ga, Fe, Zn, Cr, and Ni. Al, Ga, and Fe reduce the spacing between twin boundaries while Zn, Cr, and Ni have little effect on the microstructure. The substitutions of the above elements for Cu reduce the intragrain critical current densities (J_c's) except for the case of Ni where J_c is unchanged. Thus, the reduction of the twin boundary spacings by these substitutions does not increase critical current densities.

19910 Quasielastic and inelastic spin fluctuations in superconducting $La_{2-x}Sr_xCuO_4$. Birgeneau, R.J. (Physics Dept., Brookhaven National Lab., Upton, NY (USA)); Shirane, G.; Kostner, M.A.; Thurston, T.R.; Endoh, Y.; Kakurai, K.; Yamada, K.; Hidaka, Y.; Murakami, T. pp. 341 of Mechanisms of high temperature superconductivity. Kamimura, H.; Oshiyama, A. Springer-Verlag New York Inc., New York, NY (1989). DOE Contract AC02-76CH00016. (CONF-8810437–: Mechanisms of high temperature superconductivity, Hakone (Japan), 24-27 Oct 1988).

The authors review results of recent neutron scattering studies of the spin fluctuations in samples of $La_{1.89}Sr_{0.11}CuO_4$ which are ~ 80% superconducting with T_c = 10 K. The structure factor, S(Q), reflects three dimensional modulated spin correlations with an in-plane correlation length of order 18 +- 6 A. The fluctuations evolve with temperature from being predominantly dynamic at high temperatures to mainly quasielastic at low temperatures. No significant differences are observed in the normal and superconducting states.

19911 Fabrication of high-T_c superconducting oxides by oxidation of ductile alloy precursors. Early, E.A. (Univ. of California, San Diego, La Jolla, CA (US)); Guevara, M.G.; Seaman, C.L.; Wu, M.G.; Simnad, M.T.; Maple, M.B. pp. 693 of High temperature superconducting compounds: Processing and related properties. Whang, S.H.; DasGupta, A. The Metallurgical Society Inc., Warrendale, PA (1989). (CONF-8902140–: High temperature superconducting compounds: processing and related properties, Las Vegas, NV (USA), 27-28 Feb 1989).

The authors have investigated a method of preparing high-T_c superconducting oxides that overcomes the problem of brittleness in conventional ceramic oxides. In this method, the metallic elements of the oxide are induction-melted with Ag to form an alloy precursor. Mechanical tests performed on alloys containing 90% Ag show that they are ductile. The microstructure of the alloy is shown, as well as results from differential thermal analysis. Controlled oxidation of the alloy, studied by thermogravimetric analysis, forms an oxide - silver composite. The oxide is high-T_c superconducting $YBa_2Cu_3O_{7-\delta}$ as evidenced by observation of the Meissner effect at 77 K and by X-ray diffraction measurements of the composite. Scanning electron microscopy reveals the structure of the oxide, while photomicroscopy shows the microstructure of the composite.

The superconductivity of the oxide is characterized both by magnetic susceptibility and by electrical resistivity, and the transport and magnetization critical current densities of the oxide are measured.

19912 Shock compaction of $YBa_2Cu_3O_{7-x}$ and $HoBa_2Cu_3O_{7-x}$ powders in a metal matrix. Nellis, W.J. (Lawrence Livermore National Lab., Univ. of California, Livermore, CA (US)); Holt, J.B.; Kamegai, M.; Smith, G.S.; Seaman, C.L.; Maple, M.B.; Early, E.A.; Hinks, D.G.; Dabrowski, D. pp. 693 of High temperature superconducting compounds: Processing and related properties. Whang, S.H.; DasGupta, A. The Metallurgical Society Inc., Warrendale, PA (1989). DOE Contract W-7405-ENG-48. (CONF-8902140–: High temperature superconducting compounds: processing and related properties, Las Vegas, NV (USA), 27-28 Feb 1989).

Shock compaction of powders has several features with potential for processing high-J_c oxide superconductors. This paper summarizes results of compactions using single-phase orthorhombic powder specimens of $YBa_2Cu_3O_{7-x}$ or $HoBa_2Cu_3O_{7-x}$ mixed with 30 vol % Ag. Representative pressure histories were calculated with a two-dimensional finite-element computer code. X-ray diffraction, optical microscopy, magnetic susceptibility, and electrical resistance measurements were made on the recovered compacts. X-ray and magnetic data show these oxide powders to be robust to shock compaction, essentially maintaining their chemical and crystal structures, oxygen stoichiometry, and bulk superconductivity to shock pressures well above 100 kbar. Approaches to increase J_c are discussed.

19913 Processing chemically prepared Tl-Ca-Ba-Cu oxide superconductors. Voigt, J.A. (Sandia National Labs., Albuquerque, NM (USA)); Bunker, B.C.; Hammetter, W.F.; Ginley, D.S.; Venturini, E.L.; Kwak, J.F.; Lamppa, D.L. pp. 693 of High temperature superconducting compounds: Processing and related properties. Whang, S.H.; DasGupta, A. The Metallurgical Society Inc., Warrendale, PA (1989). DOE Contract AC04-76DP00789. (CONF-8902140–: High temperature superconducting compounds: processing and related properties, Las Vegas, NV (USA), 27-28 Feb 1989).

The recently discovered Tl-Ca-Ba-Cu oxide high temperature superconductors have proven difficult to synthesize in phase pure form. Thallium volatility has been difficult to control, and the resulting materials can contain a large number of thallium-containing phases having different compositions and superconducting properties. The authors discuss how they developed a chemical synthesis technique for Tl-based superconductors specifically to prepare materials with enhanced phase purity. The Tl-based powders were made by precipitation from aqueous solution. The desired cation stoichiometry of the precipitate was controlled via the solution compositions. The powders were calcined and sintered into superconducting ceramics with critical current densities of 1570 A/cm^2 at 76 K. Investigation of the calcination step has shown the chemprep powders to be more reactive with respect to the formation of desired superconducting phases than conventionally prepared mixed-oxide precursor powders. Also, the evolution of phases during calcination is dependent on the powder synthesis method.

19914 Anisotropic transport in Y-Ba-Cu-O and Bi-Sr-Ca-Cu-O. Zettl, A. (Dept. of Physics, Univ. of California at Berkeley, and Materials and Chemical Sciences Div., Lawrence Berkeley Lab., Berkeley, CA (USA)); Behrooz, A.; Briceno, G.; Creager, W.N.; Crommie, M.F.; Hoen, S.; Pinsukanjana, P. pp. 341 of Mechanisms of high temperature superconductivity. Kamimura, H.; Oshiyama, A. Springer-Verlag New York Inc., New York, NY (1989). DOE Contract AC03-76SF00098. (CONF-8810437–: Mechanisms of high temperature superconductivity, Hakone (Japan), 24-27 Oct 1988).

The anisotropic normal state transport properties of the superconducting oxides Y-Ba-Cu-O and Bi-Sr-Ca-Cu-O are investigated by dc resistivity, thermoelectric power, high frequency conductivity, and uniaxial stress effects in single crystals. The authors explore the superconducting state by measurements of T_c under c-axis stress, and oxygen isotope substitution. Energy gap structure is investigated by break junction single-crystal tunneling.

19915 Effect of the material redistribution during annealing on formation of superconducting Bi-Sr-Ca-Cu-O thin films. Dhere, N.G. (Solar Energy Research Institute, 1617 Cole Boulevard, Golden, CO (USA)); Matson, R.J.; Dhere, R.G. pp. 693 of High temperature superconducting compounds: Processing and related properties. Whang, S.H.; DasGupta, A. The Metallurgical Society Inc., Warrendale, PA (1989). DOE Contract AC02-83CH10093. (CONF-8902140–: High temperature superconducting compounds: processing and related properties, Las Vegas, NV (USA), 27-28 Feb 1989).

Bi-Sr-Ca-Cu-O think films are being studied extensively because of their potential for applications in superconducting devices and components. Bi-based thin films deposited on unheated substrates are amorphous and insulating. Superconducting thin films are obtained by post-annealing near the melting point. Melting at temperatures above 865^{0}C may also help in improving the homogeneity. The authors discuss how, during the melting, considerable material redistribution can take place in Bi-Sr-Ca-Cu-O thin films deposited on unheated substrates. 85 K $Bi_2Sr_2CaCu_2O_8$ phase is known to be the most stable crystalline phase in Bi-based superconducting compounds. 110 K $Bi_2Sr_2Ca_2Cu_3O_{10}$ phase is more difficult to form and usually coexists with 85 K and even 22 K $Bi_2Sr_2CuO_6$ phase. The material redistribution results in strontium and calcium rich regions or nodules in the central portion of the films, while copper oxide nodules are formed at the rims. Such a material re-distribution is detrimental to the formation of the 110 K $Bi_2Sr_2Ca_2Cu_3O_{10}$ phase. Factors which can help in reducing the material re-distribution are discussed.

19916 Superconducting ceramic coatings fabricated by the plasma spray process. Varacalle, D.J. (Idaho National Engineering Lab., EG and G Idaho, Inc., P.O. Box 1625, Idaho Falls, ID (US)); Telschow, K.L.; Smolik, G.R. pp. 693 of High temperature superconducting compounds: Processing and related properties. Whang, S.H.; DasGupta, A. The Metallurgical Society Inc., Warrendale, PA (1989). DOE Contract AC07-76ID01570. (CONF-8902140–: High temperature superconducting compounds: processing and related properties, Las Vegas, NV (USA), 27-28 Feb 1989).

The Idaho National Engineering Laboratory (INEL) is developing plasma spray coatings of metal oxide superconductors. The powder system being researched is $YBa_2Cu_3O_x$. In prior plasma spray experiments (1-3) superconducting transition temperatures greater than 77 K were obtained for annealed coatings. Indications of better superconducting properties at lower power settings prompted a continuation of the INEL work with a focus on the optimization of processing parameters. Results obtained with twelve combinations of gas mixtures and power levels are reported here.

19917 Effect of synthesis history on compositional homogeneity and microstructure of $YBa_2Cu_3O_{7-x}$ superconducting films. Debsikdar, J.C. (Idaho National Engineering Lab., EG and G Idaho, Inc., P.O. Box 1625, Idaho Falls, ID (US)); Samsel, E.G.; Sellers, C.H.; Miley, D.V. pp. 693 of High temperature superconducting compounds: Processing and related properties. Whang, S.H.; DasGupta, A. The Metallurgical Society Inc., Warrendale, PA (1989). DOE Contract AC07-76ID01570. (CONF-8902140–: High temperature superconducting compounds: processing and related properties, Las Vegas, NV (USA), 27-28 Feb 1989).

Thick film superconductors were fabricated under identical conditions using nonaqueous slurries of two Y-Ba-Cu-oxide powders synthesized by sol-gel and conventional approaches. The sol-gel approach involved reactions of soluble metal alkoxide precursors, also synthesized in our laboratory. The conventional approach involved solid-state reactions of $BaCO_3$, Y_2O_3, and CuO precursors. These powders were compared in particle morphology, phase composition, chemical homogeneity, and superconducting property to examine the correlation between powder characteristics and the film qualities. The results of this study are presented. They suggest that it is technically feasible to fabricate chemically homogeneous, polycrystalline, oriented thick film on a single crystal substrate using sol-gel powder as the precursor; the conventional powder produced chemically inhomogeneous, polycrystalline, randomly oriented films with transgranular cracks on the same substrate. The microstructural features of these films were significantly different and are related to characteristics of the precursor powders.

19918 Phase equilibrium and processing of $RE_1Ba_2Cu_3O_{7-x}$ superconductors. McCallum, R.W. (Ames Lab. and Dept. of Materials Science and Engineering, Iowa State Univ., Ames, IA (US)); Ullman, J.E.; Kramer, M.J.; Chumbley, L.S.; Verhoeven, J.D. pp. 693 of High temperature superconducting compounds: Processing and related properties. Whang, S.H.; DasGupta, A. The Metallurgical Society Inc., Warrendale, PA (1989). DOE Contract W-7405-ENG-82. (CONF-8902140–: High temperature superconducting compounds: processing and related properties, Las Vegas, NV (USA), 27-28 Feb 1989).

The processing of $RE_1Ba_2Cu_3O_{7-x}$ superconductors is greatly influenced by the presence of a number of liquid phases within the RE_2O_3-BaO-CuO psuedoternary phase diagram. These liquids promote exaggerated grain growth and liquid phase sintering well below the peritectic decomposition temperature of the 123 phases. Depending upon the reaction path taken, the liquid may occur at as low as 890°C or as high as 1000°C. The effects of calcination temperature, final sintering temperature, and process gas flow on the microstructure of the material is demonstrated. While the phase diagram is qualitatively the same for the rare earths investigated, there are significant changes in the melting temperatures as the rare earth is changed.

19919 Magnetically aligned crystallites: Paramagnetic anisotropy and critical current density. . Lee, B.W. (Dept. of Physics and Institute for Pure and Applied Physical Sciences, Univ. of California, San Diego, La Jolla, CA (US)); Ferreira, J.M.; Hake, R.R.; Maple, M.B.; Seaman, C.L.; Zhou, H.; Kuric, M.V.; Guertin, R.P. pp. 693 of High temperature superconducting compounds: Processing and related properties. The Metallurgical Society Inc., Warrendale, PA (1989). (CONF-8902140–: High temperature superconducting compounds: processing and related properties, Las Vegas, NV (USA), 27-28 Feb 1989).

The authors describe the paramagnetic anisotropy of the $RBa_2Cu_3O_{7-\delta}$ compounds investigated by aligning single crystal grains of the compounds which had been mixed in epoxy at room temperature, and then allowing the epoxy to harden in an applied magnetic field H_A = 18 KOe. X-ray analysis indicated that the c-axis of the crystallites aligns parallel to H_A for R = Y,Nd, Sm,Dy,Ho and perpendicular to H_A for R = Eu,Er, Tm, and Yb. Except for Y,Sm, and Eu, the alignment direction (easy axis of magnetization) correlates with the sign of the second-order Stevens factor α_J of the CEF Hamiltonian. In order to investigate the low temperature paramagnetic anisotropy and critical current density J_c, magnetization curves were measured at 4.3 K. The highest J_c(4.3 K,5 kOe) was estimated to be -10^7 A/cm^2 for R =Dy.

19920 On the isotope effect in $YBa_2Cu_3O_7$: Measurements for two methods of synthesis. . Clarke, A.P. (Center for Materials Science and P-10 Div., Los Alamos National Lab., Mail Stop K-765, Los Alamos, NM (US)); Yvon, P.J.; Schwarz, R.B.; Thompson, J.D.; Meisenheimer, R.; Bernardez, L. pp. 693 of High temperature superconducting compounds. Whang, S.H.; DasGupta, A. The Metallurgical Society Inc., Warrendale, PA (1989). (CONF-8902140–: High temperature superconducting compounds: processing and related properties, Las Vegas, NV (USA), 27-28 Feb 1989).

The authors describe how they prepared superconducting samples of $YBa_2Cu_3(^{18}O)_{7-x}$ and $YBa_2Cu_3(^{16}O)_{7-x}$ by two techniques: burning powder of YBa_2Cu_3 in $^{18}O_2$ and $^{16}O_2$ and crystallizing amorphous powder of $YBa_2Cu_3(^{16}O)_{7.8}$ in flowing $^{18}O_2$ and $^{16}O_2$. The percent of ^{18}O in the $YBa_2Cu_3(^{18}O)_{7-x}$ samples was 96.5 at .% for the first method and 92 at .% for the second method. The $YBa_2Cu_3(^{16}O)_{7-x}$ samples had 99.8 at .% ^{16}O. Susceptibility measurements of the superconducting transition temperature show an oxygen isotope effect of 0.4 K for both methods.

19921 Oxidation kinetics and microcracking in superconducting $YBa_2Cu_3O_{7-x}$ ceramics. Richardson, T.J. (Materials and Chemical Sciences Div., Lawrence Berkeley Lab., Berkeley, CA (US)); DeJonghe, L.C. pp. 693 of High temperature superconducting compounds: Processing and related properties. Whang, S.H.; DasGupta, A. The Metallurgical Society Inc., Warrendale, PA (1989). (CONF-8902140–: High temperature superconducting compounds: processing and related properties, Las Vegas, NV (USA), 27-28 Feb 1989).

The anisotropic expansion and contraction of crystals of $YBa_2Cu_3O_{7-x}$ (YBCO) during thermal processing oxygenation, and cryo-cooling result in intra-and intergranular stresses that are largely relieved by microcracking. Acoustic emission signals produced during microcracking are qualitative and quantitative measures of the degradation in strength and electrical connectivity in a sintered ceramic. A method is described for detecting and evaluating acoustic emission generated within YBCO samples during processing. The intensity, onset temperature and duration of cracking during post-sintering cooldown depend upon the oxygen partial pressure. Sudden changes in oxygen pressure also induce cracking. The influence on cracking of sample porosity is discussed.

19922 Bismuth and thallium superconductor materials: Structural, magnetic, transport and compositional characterization of ceramic, crystal, and film materials. . Morosin, B. (Organization 1131, Sandia National Labs., Albuquerque, NM and Livermore, CA (USA)); Venturini, E.L.; Ginley, D.S.; Bunker, B.C.; Stechel, E.B.; McCarty, K.F.; Voigt, J.A.; Kwak, J.F.; Schirber, J.E.; Emin, D. pp. 693 of High temperature superconducting compounds: Processing and related properties. Whang, S.H.; DasGupta, A. The Metallurgical Society Inc., Warrendale, PA (1989). DOE Contract AC04-76DP00789. (CONF-8902140–: High temperature superconducting compounds: processing and related properties, Las Vegas, NV (USA), 27-28 Feb 1989).

Structural, magnetic, transport and compositional properties of ceramic, crystal and thin film forms of high temperature Cu-O based superconductors in the BiCaSrCuO and TlCaBaCuO systems are reviewed. The emphasis is on the development of a fundamental understanding of the synthesis protocol and essential structural features and their relation to the superconducting transition temperature, transport, and magnetic properties. Millimeter-sized plates of both single crystals and syntactic intergrowth polycrystals have been grown and characterized by x-ray diffraction, scanning electron microscopy, energy dispersive x-ray analysis, Raman microscopy, magnetization and pressure dependence of the superconducting transition temperature. These data have been correlated with processing parameters including post-growth oxygen and/or annealing.

19923 NMR study of hydrogen location and motion in yttrium-hydrogen. Barnes, R.G. (Ames Lab., IA (USA)); Torgeson, D.R.; Bastow, T.J.M.; West, G.W.; Seymour, E.F.W; Smith, M.E. *Zeitschrift fuer Physikalische Chemie (Wiesbaden) (Germany, F.R.)*, 164(pt.1): 867-872 (1989). DOE Contract W-7405-ENG-82. (CONF-880969–: Metal hydrogen systems fundamentals and applications conference, Stuttgart (Germany, F.R.), 4-9 Sep 1988).

Hydrogen disorder in α-$YH_{0.18}$ makes the ^{89}Y resonance unobservable below 350 K. Ordering of hydrogen pairs is insufficient down to 150 K to yield an interpretable ^{89}Y spectrum. Above 350 K, averaging by hydrogen diffusion reveals ^{89}Y and ^{1}H lineshapes of axial symmetry. In the cubic dihydride, two ^{89}Y lines occur in some samples, one with symmetry less than cubic, suggesting hydrogen ordering below 280 K. (orig.).

19924 2D and 3D magnetic behavior of Er in $ErBa_2Cu_3O_7$. Lynn, J.W. (Center for Superconductivity Research, Department of Physics, University of Maryland, College Park, Maryland 20742 (USA)— National Institute of Standards and Technology, Gaithersburg, Maryland 20899 (USA)); Clinton, T.W.; Li, W.; Erwin, R.W.; L *Physical Review Letters (USA)*, 63(23): 2606-2609 (4 Dec 1989). DOE Contract W-31-109-ENG-38.

Neutron scattering has been used to study the magnetic order of the Er ions in superconducting $ErBa_2Cu_3O_7$. Above the 3D Neel temperature (T_N=0.618 K) a rod of scattering characteristic of 2D behavior is unambiguously observed, showing that the magnetic interactions of the rare-earth ions are highly anisotropic; below T_N the order parameter follows the exact Onsager solution for a 2D Ising antiferromagnet. At low T, two separate types of simple 3D antiferromagnetic structures are found, one characterized by a wave vector of (1/2,0,0), and the other by (1/2,0,1/2).

19925 Properties of $YBa_2Cu_3Ag_xO_{7-\delta}$ composite superconductors. Ganapathi, L. (Department of Materials Science and

Engineering, North Carolina State University, Raleigh, North Carolina 27695-7916 (US)); Kumar, A.; Narayan, J. *Journal of Applied Physics (USA)*, 66(12): 5935-5939 (15 Dec 1989).

Superconducting properties and microstructures of the $YBa_2Cu_3Ag_xO_{7-\delta}$ composites have been studied as a function of silver content, $0<x<6$, using a variety of techniques. The superconducting transition temperature T_c of these composites was found to be the same, ~90 K, for the above range of composites. For values of $x>3$, small quantities of 211 phase were detected along the grain boundaries. Alloy formation between Ag and Cu is proposed to take place which makes the residual composition poor in copper, resulting in the formation of nonsuperconducting 211 phase. The silver is observed in the form of precipitates at very low concentrations of silver, indicating that silver does not substitute for copper in $YBa_2Cu_3O_7$. Lattice parameters of the composites were found to be invariant throughout the above composition range. The addition of Ag_2O in the starting composition seems to stabilize the stoichiometric $YBa_2Cu_3O_7$ by way of decomposition to Ag and O. As a result, the incorporation of oxygen and recovery of superconducting properties is enhanced in the silver composites.

19926 Ambient temperature thermal conductivity of $YBa_2Cu_3O_{7-x}$. Williams, R.K. (Metals and Ceramics Division, Oak Ridge National Laboratory, P. O. Box 2008, Oak Ridge, Tennessee 37831 (USA)); Graves, R.S.; Kroeger, D.M.; Marsh, G.C.; Scarbrough, J.O.; Brynestad, J. *Journal of Applied Physics (USA)*, 66(12): 6181-6184 (15 Dec 1989). DOE Contract AC05-84OR21400.

A comparative method was used to measure the thermal conductivity λ of a $YBa_2Cu_3O_{7-x}$ sample over the temperature range 305–360 K. Using one sample, data were obtained at two different x levels. Surprisingly, the smaller x value (higher T_c) produced a lower thermal conductivity. This observation is discussed in terms of scattering of phonons by point defects and electrons.

19927 Silver-coated superconducting ceramic powder. Ferrando, W. To Department of the Navy, Washington, DC. USA Patent Application 7-389,220. 2 Aug 1989. 16p. Available from NTISPC N03/MF A01.

This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of application available NTIS.

A process for silver coating superconducting ceramic powder by: (1) coating the superconducting ceramic powder particles with silver nitrate; (2) melting the $AgNO_3$ so that it wets and forms a uniform coating over the surfaces of the particles; and (3) decomposing the $AgNO_3$ to form a thin, uniform coating of silver metal on the surfaces of the particles. The product is a loose powder of superconducting ceramic particles which are uniformly coated with silver metal. The powder can be cold worked (e.g., swaged, forged, etc.) to form superconducting structures such as rods or wires.

3606 Other Materials

Refer also to citation(s) 19489, 19492, 19493, 19494, 19495, 19629, 19816, 19848, 19868, 19897, 20012, 20084, 20130, 20142, 20617, 20994, 21058

19928 (AD-A–214152/1/XAB) **Plasma etching of ion-implanted polysilicon.** Karulkar, P.C.; Wirzbicki, M.A. Massachusetts Inst. of Tech., Lexington, MA (USA). Lincoln Lab. Sep 1989. 6p. (JA–6165). Available from NTIS, PC A02/MF A01.

Pub. in Jnl. of the Electrochemical Society, Vol. 136, No. 9, 2716-2720(Sep 1989).

Ion implantation is increasingly used to dope polysilicon gates to obtain lower resistivities and also to control the cumulative time-temperature cycling of VLSI wafers. Dry etching of polysilicon doped with phosphorus by ion implantation was studied using a parallel-plate etcher and two different etch chemistries sulfur haxafluoride-O_2-argon and SF6-CCl2F2-Ar. These two etch procedures were previously found to result in excellent etching of polysilicon which was doped with phosphorus by solid-source diffusion. Large differences in the cross-sectional profiles of ion-implanted polysilicon were found while using the two chemistries. SF6-dichlorodifluoromethane-Ar chemistry caused sharp notch-like undercuts, while the SF6-O2-Ar chemistry exhibited linewidth loss without any notching. Examples of the cross sections of ion-implanted polysilicon are presented along with a discussion of the possible mechanisms that cause the different cross-sectional profiles in the two etch chemistries. The notching is explained in terms of the variation in the dopant concentration and in the structure of ion-implanted polysilicon at different depths. The absence of notching in the cross section of ion-implanted polysilicon etched in the SF6-O2-Ar chemistry is explained by proposing that the interaction of oxygen in the SF6-O2-Ar chemistry with the etched surface makes the chemistry less sensitive to the dopant concentration in the etched material. Results of a simple experiment which support the proposed explanation are presented.

19929 (AD-A–214187/7/XAB) **Examination of blistering of fiberglass-reinforced laminates. Final report, 1986-1987.** Wirth, D.; Hattery, G.; Ensminger, D.; Stets, J.; Dick, R. Battelle Columbus Labs., OH (USA). 26 Jun 1987. 49p. Available from NTIS, PC A03/MF A01.

Four nondestructive testing devices were used on 21 fiberglass laminated test panels prepared by boat companies and material suppliers. Each set of panels had been formulated using (1) normal layup, (2) excess catalyst, (3) deficient catalyst, (4) low-temperature cure, and (5) excess water in fiberglass. The four testing devices were (1) ultrasonic inspection, (2) dielectric moisture detector, (3) neutron source device, and (4) thermography IR detector.

19930 (CEA-CONF–9859) **Seismic behaviour of concrete shear walls.** Wang, F. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. d'Etudes Mecaniques et Thermiques); Gantenbein, F.; Duretz, C.; Dalbera, J. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. d'Etudes Mecaniques et Thermiques. 1989. 10p. (In French). (CONF-8904262–: 2. national symposium on paraseismic engineering, Saint-Remy-les-Chevreuse (France), 18-20 Apr 1989). Order Number DE90752523. Available from NTIS (US Sales Only), PC A02/MF A01.

Concrete shear walls have an important contribution to building stiffness. So, it is necessary to know their behaviour under seismic loads. The ultimate behaviour of shear walls under dynamic loadings has been studied. The study includes: - A description of the non linear global model based on cyclic static tests. - Non linear time history calculations for various forcing functions. The comparison of linear and non linear results have shown important margins related to the ductility when the bandwidth of the forcing function is narrow and centred on the wall natural frequency.

19931 (CONF-891111–3) **Assessing tight gas reservoir quality using petrography and core analysis.** Soeder, D.J. Institute of Gas Technology, Chicago, IL (USA). [1989]. 9p. Sponsored by Institute of Gas Technology. From International gas research conference; Tokyo (Japan); 6-9 Nov 1989. Available from OSTI; Institute of Gas Technologyh, 3424 South State Street, Chicago, IL 60616.

The transport of liquids and gas through the pore systems of low-permeability reservoir rocks is difficult to measure using standard core analysis techniques. Very low flow rates and high capillary pressures force the analyses to take so much time that the data cannot be used for completion decisions. Several approaches have been taken in recent years to provide reservoir quality assessments of tight formations on a time scale applicable to well completion decision-making. A data base of high-precision, steady-state permeability measurements on tight gas reservoir samples has been combined with quantitative petrographic image analysis to correlate rock matrix flow properties with pore size and pore geometry in the samples. The goal of this research is to utilize petrography on chips and cuttings to assess tight gas reservoir quality, in conjunction with the fast-turnaround, unsteady-state permeabilities measured commercially on tight core samples. 10 refs., 5 figs.

19932 (CONF-891119–100) **The effect of fiber coatings on interfacial shear strength and the mechanical behavior of ceramic composites.** Lowden, R.A.; More, K.L. Oak Ridge National Lab., TN (USA). [1989]. 10p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC05-84OR21400. From Materials Research

Society fall meeting; Boston, MA (USA); 27 Nov - 2 dec 1989. Order Number DE90007574. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Thin coatings (boron nitride and carbon) deposited on ceramic fibers prior to densification employing chemical vapor infiltration techniques have been used to limit fiber-matrix bonding. This has resulted in improvements in strength and toughness at room and elevated temperatures in Nicalon® fiber-reinforced/SiC matrix composites. The properties of the fiber-matrix interface in fiber-reinforced ceramic composites have been examined utilizing an indentation method in which a standard microhardness indentor is used to push on fibers embedded in the ceramic matrix. Compositions and microstructures at the interface have been characterized employing analytical electron microscopy. Correlations between interfacial phenomena and observed mechanical behavior have been made. 16 refs., 5 figs., 1 tab.

19933 (CONF-900268–1) **Heat capacities of solid polymers (The Advanced THermal Analysis System, ATHAS).** Wunderlich, B. Oak Ridge National Lab., TN (USA); Tennessee Univ., Knoxville, TN (USA). Dept. of Chemistry. [1990]. 18p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract AC05-84OR21400. From 3. Minerals, Metals and Materials Society world symposium on lead-zinc (Pb-Zn) and related metals; Anaheim, CA (USA); 18-21 Feb 1990. Order Number DE90007130. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The thermal properties of solid, linear macromolecules are accessible through heat capacity measurements from about 10 K to the glass transition. By measuring and collecting data on over 150 polymers, a data bank was established and used as a base for detailed correlation with an approximate frequency spectrum for the polymers. Besides assessment of the entropy at zero kelvin of disordered polymers, this heat capacity knowledge has helped in the elucidation of partial phase transitions and conformationally disordered crystal phases. A link has also been established to measurements of mobility through solid state nuclear magnetic resonance. Most recently heat capacity measurements have been linked to full dynamic simulations of crystal segments of 1900 chain atoms. Questions of disorder and anharmonicity can thus be analyzed. The work is summarized as the Advanced Thermal Analysis System, ATHAS. 27 refs., 26 figs.

19934 (CONF-900278–2) **Thermal performance of a closed-cell foamboard insulation containing HCFC-22.** Graves, R.S. (Oak Ridge National Lab., TN (USA)); Yarbrough, D.W.; Christian, J.E.; Destephen, M.R. Oak Ridge National Lab., TN (USA). [1990]. 26p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. From 6. international conference on thermal insulation; San Francisco, CA (USA); 12-14 Feb 1990. Order Number DE90007054. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A development extruded polystyrene foamboard insulation containing cholorodifluoromethane (HCFC-22) has been monitored in the laboratory and in the field for about two years. Experimental data from three apparatuses have been used to construct a correlation of apparent thermal conductivity with time that can be used to predict the thermal resistivity of the unfaced nominal two-inch-thick foamboard to better than 3% with 95% confidence. Field measurements confirm the decrease in thermal resisitivity with time that was observed in the laboratory. The initial thermal resistivity of the foamboard was 5.90 ($ft^2 \cdot hr \cdot {}^\circ F/Btu \cdot in$), the thermal resistivity at 180 days was 4.37, and the thermal resistivity as time $\rightarrow \infty$ was determined from the correlation to be 3.97. A computational model for heat transfer through the foamboard was used to predict thermal resistivity as a function of time. The model requires gas diffusion data, gas-mixture thermal conductivities, and solid phase thermal conductivity. The model indicates that radiation accounts for about 30% of the total heat flow through the insulation. 15 refs., 4 figs., 3 tabs.

19935 (CONF-900406–4) **Vapor hydration and subsequent leaching of transuranic-containing SRL and WV glasses.** Bates, J.K.; Ebert, W.L.; Gerding, T.J. Argonne National Lab., IL (USA). Sep 1989. 9p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-31109-ENG-38. From International conference for high-level radioactive waste management; Las Vegas, NV (USA); 8-12 Apr 1990. Order Number DE90002261. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Prior to contact by liquid water and subsequent leaching, high-level nuclear waste glass subject to disposal in the unsaturated environment at Yucca Mountain, Nevada, will be altered through contact with humid air. Conditions could range from temperatures as high as 200°C to ambient repository temperature after cooling and relative humidities up to 100% depending on the air flow and heat transport dynamics of the waste package and near field environments. However, under any potential set of temperature/humidity conditions, the glass will undergo alteration via well-established vapor phase hydration processes. In the present paper, the results of a set of parametric experiments are described, whereby vapor phase hydrated glasses were subjected to leaching under static conditions. The purpose of the experiments was to (1) compare the leaching of vapor phase altered glass to that of fresh glass, (2) to develop techniques for determining the radionuclide content of secondary phases that formed during the hydration reaction, and (3) to provide a basis for performing long-term saturated and unsaturated testing of vapor hydrated glass. 3 refs., 2 figs., 2 tabs.

19936 (DOE/ER/45156–T3) **Ion mixing and surface modification in metal-semiconductor systems: Final technical report, August 1, 1987–January 31, 1990.** Lau, S.S. (California Univ., San Diego, La Jolla, CA (USA). Dept. of Electrical and Computer Engineering); Mayer, J.W. California Univ., San Diego, La Jolla, CA (USA). Dept. of Electrical and Computer Engineering; Cornell Univ., Ithaca, NY (USA). Dept. of Materials Science and Engineering. 1990. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract FG03-84ER45156. Order Number DE90007557. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This research is a collaborative program between the University of California at San Diego and Cornell University to investigate the phenomenon of ion mixing in metal-semiconductor systems. The research effort also involves interactions with the Oak Ridge National Laboratory under the Surface Modification and Characterization Collaborative Research Center Program (D. B. Poker, C. W. White, J. R. Roberto and B. R. Appleton). The primary objectives of this research program were to investigate (1) the effect of damage distribution to test whether atomic transport was determined by damage concentration. The identity and the control of the moving species are critical factors in forming uniform, ion-mixed layers, and (2) the effect of substrate temperature on the moving species and on the reaction product under ion mixing condition. This part of the research was designed to correlate the interplay between thermodynamical driving forces and kinetic restrictions in ion induced reactions.

19937 (DOE/ER/45368–2) **Multicomponent glass surfaces structure and adsorption: Progress report, January 1, 1989–December 31, 1989.** Garofalini, S.H. Rutgers–the State Univ., New Brunswick, NJ (USA). Dept. of Ceramics. [1989]. 3p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-88ER45368. Order Number DE90007179. Available from NTIS, PC A02/MF A01 - OSTI.

In this research program, we are determining the surface structure of multicomponent silicate glasses and the effect of that structure on adsorption behavior using both computational techniques (molecular dynamics simulations) and experimental surface analysis.

19938 (Juel–2299) **The production and growth of monocrystalline Si/$CoSi_2$/Si heterostructures after high dose ion implantation.** Kohlhof, K. Kernforschungsanlage Juelich GmbH (Germany, F.R.). Inst. fuer Schicht- und Ionentechnik; Koeln Univ. (Germany, F.R.). Aug 1989. 94p. (In German). Order Number DE90753712. Available from NTIS (US Sales Only), PC A05/MF A01.

$CoSi_2$ is a favourable candidate for low ohmic interconnects in integrated circuits with high temperature stability. Its CaF_2 structure is very similar to the diamond structure of Si with a lattice mismatch of only -1.2%. This allows epitaxial growth of Si/$CoSi_2$/Si heterostructures required for three dimensional device applications. High dose Co^+ implantation with subsequent annealing is a valuable method to form buried epitaxial $CoSi_2$ layers with sharp

interfaces both in (111)- and (100)-Si. The excellent crystalline quality of the surface Si layer enables the epitaxial growth of an additional Si layer to bury the silicide layer deeper into the substrate. Buried $CoSi_2$ lines of several microns width were fabricated by implanting the Co^+ ions through a thermally grown SiO_2 mask patterned by photolithography. Both steps are necessary for the application of ion beam synthesis to microelectronics. (orig./BHO).

19939 (LA-UR-90-165) **Laser mass spectrometric studies of high temperature superconductor ablation.** Estler, R.C.; Nogar, N.S. Los Alamos National Lab., NM (USA). 1990. 8p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-900140-10: SPIE optics, electro-optics and laser applications in science and engineering conference and exhibition, Los Angeles, CA (USA), 20-25 Jan 1990). Order Number DE90006518. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Laser ablation of bulk High Temperature Superconductor (HTS) material promises to provide a useful means of producing high quality HTS thin films. Mass spectrometric probes of the ablation plume provide a microscopic understanding of the ablation event and plume development as well as providing a process monitor for the thin film production. Detection of the nascent ions in the plume provides real time analytical information, e.g., identification of impurities, major and minor ablation species, etc. The common contaminants sodium and strontium have been easily detected by this technique in a variety of different HTS bulk materials. In contrast, detection of the ablated neutral species by Resonance Ionization Mass Spectrometry (RIMS) provides physical information about the ablation process. Time-of-flight/RIMS detection of Cu, Y, and BaO ablated from $YBa_2Cu_3O_x$ indicates the ablation involves post-desorption gas phase collisions, thereby influencing the ablation chemistry and dynamics (e.g., angular and velocity distributions). Approximately equal velocities are observed for all neutral species at constant ablation laser fluence. 17 refs., 4 figs.

19940 (LBL-28096) **Dislocation behaviour in Ge_xSi_{1-x} epilayers on (001)Si.** Kvam, E.P.; Maher, D.M.; Humphreys, C.J. Lawrence Berkeley Lab., CA (USA). Nov 1989. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-891119-95: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989). Order Number DE90007063. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We have observed that the nature of misfit dislocations introduced near the critical thickness in Ge_xSi_{1-x} alloys on (001)Si changes markedly in the region $0.4 \leq x \leq 0.5$. At or below the lower end of this compositional range, the observed microstructure is comprised almost entirely of 60° type dislocations, while at the high end, the dislocation structure is almost entirely Lomer edge type. Concurrent with this change, the dislocation density at the top of the epilayer varies by a factor of about 60X. Similarly, several other observables (e.g., dislocation length and spacing) also change appreciably. Part of the reason for the morphological variation seems to be a change in the source for dislocation introduction, in conjunction with a change in glide behavior of dislocations as a function of film thickness. Evidence will be presented that indicates strain, as well as thickness, has a critical value for some dislocation introduction mechanisms, and that these together determine the resulting microstructure. Furthermore, it appears unlikely that the edge-type Lomer dislocations which appear at about $x = 0.5$ are either introduced directly, by climb, or grown in, as in the three-dimensional island growth and coalescence which occurs when x approaches unity. Instead, a two-step mechanism involving glissile dislocations is proposed and discussed. 9 refs., 4 figs.

19941 (LBL-28193) **Modified dislocation structures in Ge_xSi_{1-x} double epilayers on (001) Si.** Kvam, E.P. Lawrence Berkeley Lab., CA (USA). Nov 1989. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-891119-94: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989). Order Number DE90007078. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Double epilayers of different compositions of Ge_xSi_{1-x} on (001) Si are observed to have dislocation contents which differ markedly from similar single epilayers. An initial epilayer, grown below its critical thickness, underwent substantial misfit dislocation introduction, while a second epilayer, grown at a composition where edge-type misfit dislocations are normally observed to dominate the morphology, contained mostly 60° type dislocations. It is suggested that dislocation entry into the upper, high mismatch epilayer allows many dislocations to enter the buried, low mismatch epilayer, and that this in turn affects the dislocation morphology in the upper layer through strain relief. 7 refs., 3 figs.

19942 (N-90-11880) **Plasma-deposited amorphous hydrogenated carbon films and their tribological properties.** Miyoshi, K.; Pouch, J.J.; Alterovitz, S.A. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Oct 1989. 13p. (NASA-TM-102379;E-5118;NAS-1.15:102379). Available from NTIS, PC A03/MF A01.

Recent work on the properties of diamondlike carbon films and their dependence on preparation conditions are reviewed. The results of the study indicate that plasma deposition enables one to deposit a variety of amorphous hydrogenated carbon (a-C:H) films exhibiting more diamondlike behavior to more graphitic behavior. The plasma-deposited a-C:H can be effectively used as hard, wear-resistant, and protective lubricating films on ceramic materials such as Si(sub 3)N(sub 4) under a variety of environmental conditions such as moist air, dry nitrogm, and vacuum.

19943 (N-90-12009) **Growth and characterization of materials for tunable lasers in the near infrared spectral region. Semiannual progress report, 1 February-31 July 1989.** Powell, R.C.; Martin, J.J. Oklahoma State Univ., Stillwater, OK (USA). Aug 1989. 35p. (NASA-CR-185832;NAS-1.26:185832). Available from NTIS, PC A03/MF A01.

Laser spectroscopy, crystal growth, and radiation damage research was performed. The laser spectroscopy effort focused on understanding the effects of excited state absorption processes involving pump photons. This was performed on a variety of rare earth ions in different hosts. The crystal growth and radiation damage effort focused on LiFY4 (YLF) doped with rare earth ions. The results of this work is described.

19944 (N-90-12345) **Characterizations of electrical properties of highT_c superconducting materials. Center Director's discretionary fund. Final report.** Sisk, R.C.; Peters, P.N. National Aeronautics and Space Administration, Huntsville, AL (USA). George C. Marshall Space Flight Center. Sep 1989. 15p. (NASA-TM-100380;NAS-1.15:100380). Available from NTIS, PC A03/MF A01.

The automated data acquisition system developed in the Space Science Laboratory at Marshall Space Flight Center for measuring electrical properties of high temperature superconductors is described. The acquisition system, consisting of a computer and computer-controlled hardware, allows large numbers of voltage, current, temperature, and magnetic measurements to be performed on bulk and thin film samples. Typical results are shown characterizing transition temperature (T sub c), critical current density (J sub c), and magnetic properties of bulk high T(sub c) materials as a function of temperature.

19945 (PB-90-854621/XAB) **High temperature insulation. June 1970-November 1989 (Citations from the COMPENDEX data base). Report for June 1970-November 1989.** National Technical Information Service, Springfield, VA (USA). Dec 1989. 127p. Available from NTISPC N01/MF N01.

Supersedes PB-87-851127.

This bibliography contains citations concerning high-temperature thermal and electrical insulators. Applications in heat-resistant cables, industrial furnaces, high-temperature piping, transformers, and nuclear reactors are included. The performance of specific materials is discussed. (This updated bibliography contains 309 citations, 176 of which are new entries to the previous edition.)

19946 (PB-90-854795/XAB) **Radiation curable polymer coatings. January 1972-October 1989 (Citations from the US Patent data base). Report for January 1972-October 1989.** National Technical Information Service, Springfield, VA (USA). Dec 1989. 86p. Available from NTISPC N01/MF N01.

Supersedes PB-89-850747.

This bibliography contains citations of selected patents concerning methods and compositions used in radiation-curable polymer coatings. Protective and decorative coatings on metallic and nonmetallic substrates curable with light, including ultraviolet, are disclosed. Abrasion-resistant coating techniques are presented. (This updated bibliography contains 186 citations, 16 of which are new entries to the previous edition.)

19947 (PB–90-855578/XAB) **Polymeric materials combustion: Toxicity hazards and legal aspects. January 1973-December 1989 (Citations from the Rubber and Plastics Research Association data base). Report for January 1973-December 1989.** National Technical Information Service, Springfield, VA (USA). Dec 1989. 108p. Available from NTISPC N01/MF N01.

Supersedes PB–88-870431.

This bibliography contains citations concerning toxicity hazards and legal aspects of polymeric materials combustion in building, electrical and electronic applications. Flammability assessment, flame retardant additives, and toxicity standards of polymeric materials are discussed. Regulations and legislation on polymer flammability are presented. Health hazards caused by toxic gases from polymeric materials combustion are considered. (This updated bibliography contains 238 citations, 28 of which are new entries to the previous edition.)

19948 (SAND–89-1712C) **Morphological consequences of catalytic hydrogenation of polymers in the bulk.** Gilliom, L.R.; Schaefer, D.W.; Mark, J.E. Sandia National Labs., Albuquerque, NM (USA). [1989]. 13p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-891119–97: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989). Order Number DE90007276. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

When suitable catalysts are molecularly dispersed in polymers, the polymers can be modified without added solvent. This paper describes studies on the morphology of samples of trans-1,4-polybutadiene and syn-1,2-polybutadiene which have been partially deuterated in the bulk. The development of a peak in the SANS data for the 1,2-polybutadiene suggests the formation of small domains upon deuteration. Possible explanations for this observation, including chemical and physical heterogeneity, are evaluated. Results of SAXS and thermal measurements are also considered. 11 refs., 3 figs., 1 tab.

19949 (SAND–89-2512C) **Theory of polymer blends.** Curro, J.G.; Schweizer, K.S. Sandia National Labs., Albuquerque, NM (USA). [1989]. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900402–1: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990). Order Number DE90002532. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

We have recently developed a new theoretical approach to the study of polymer liquids. The theory is based on the "reference interaction site model" (RISM theory) of Chandler and Andersen, which has been successful in describing the structure of small molecule liquids. We have recently extended our polymer RISM theory to the case of polymer blends. In the present investigation we have applied this theory to two special binary blends: (1) the athermal mixture where we isolate structural effects, and (2) the isotopic mixture in which structurally identical polymer chains interact with dissimilar attractive interactions. By studying these two special cases we are able to obtain insights into the molecular factors which control the miscibility in polymer mixtures. 18 refs., 2 figs.

19950 (SAND–89-3135C) **Alternate film dielectric materials.** Foster, J.C. (General Electric Co., Largo, FL (USA). Neutron Devices Dept.); Harris, J.O.; Martinez, J.I. Sandia National Labs., Albuquerque, NM (USA). [1990]. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900371–2: 1990 capacitor and resistor technology symposium, San Francisco, CA (USA), 26-29 Mar 1990). Order Number DE90007213. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper presents data on polymeric dielectric films evaluated to support the design of high-energy-density capacitors. Evaluated materials include polycarbonate (two sources), polyphenylene sulfide, polyvinylidene fluoride, polyethermide (three sources), polyimide (four sources), polyethersulfone, and polyetherether ketone. A polyester was evaluated as the control material since many of our prior designs utilized this dielectric. The film evaluations were based on dielectric constant and dissipation factor variation as a function of temperature from −55°C to 300°C, as well as dielectric breakdown strength. Additionally, film/foil capacitors in a dry, wrap-and-fill configuration were fabricated and tested to determine insulation resistance, breakdown voltage, and radiation hardness. Results will be presented for all the evaluations based on the several criteria. 7 refs., 4 figs., 4 tabs.

19951 (SAND–90-8200) **Radiation-induced density changes and creep in surface layers of glass.** Wolfer, W.G.; Antolak, A.J. Sandia National Labs., Livermore, CA (USA). Jan 1990. 31p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90008112. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

When glass surfaces are bombarded by energetic charged particles, radiation-induced density changes happen within the damaged surface layer. As a result of the lateral constraints imposed by the undamaged substrate material, stresses are also generated within the damaged layer. A detailed analysis of the stress evolution is given together with an analysis of the surface displacement and the bending of plate-like specimens bombarded from one side. The damaged material is assumed to deform as a viscoelastic material with a power-law stress dependence. The results of this analysis are applied to earlier experimental results in order to extract creep parameters which describe this viscoelastic and radiation-induced deformation in hydrogen-free vitreous silica.

19952 (SAND–90-8205) **A statistical evaluation of the variation in laminated composite properties resulting from ply misalignment.** Hinckley, C.M. Sandia National Labs., Livermore, CA (USA). Feb 1990. 49p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DR00789. Order Number DE90006371. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A Monte Carlo simulation of ply angle deviations has been used to evaluate the distribution in properties for symmetric laminates formed from P75/930 graphite epoxy unidirectional tape. In applications where consistency of unidirectional tape. In applications where consistency of particular properties is critical, this evaluation has shown that important distinctions may be made even when laminates have essentially identical properties based on nominal ply angles. A laminate formed of 0, 60 and −60 degree plies can provide a more consistent product than one formed of 0, 90, and ±45 degree plies for the specific application requiring dimensional stability considered here. This type of analysis provides a sound basis for predicting the variation in laminate properties resulting from ply angle deviations that are likely to occur in manufacturing processes. 5 refs., 10 figs., 6 tabs.

19953 (UCID–21947) **Preliminary evaluation of the strength of pin-joints in laminated composite materials.** Groves, S.E. Lawrence Livermore National Lab., CA (USA). 8 Mar 1989. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90006353. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The objective of this evaluation is to determine the base line bearing strength of a pinned joint in a laminated composite structure. The bearing strength is defined as the load in the pin divided by the bearing area which is the product of the pin diameter and the plate thickness. The bearing strength of composite materials is not very well characterized, and it is hoped that this investigation will shed some understanding on the matter. In typical metals the bearing strength is usually twice the ultimate tensile strength. However, in composites, local anisotropies and flaws will result in the formation of high interlaminar normal stresses which cause delaminations to occur locally and thus prevents a laminated composite from ever reproducing the comparable bearing strengths found in metals. Nevertheless, composites can be designed to sustain significant bearing loads. To substantiate this claim, a series of simple tests were performed on laminated coupons. Results indicate that it is possible to achieve a very conservative bearing strength of 75

ksi in a quasi-isotropic laminated composite structure. Furthermore, it is believed that by minimizing the formation of the delaminations, bearing strengths on the order of the comparable quasi-isotropic tensile strength can be achieved. Thus the bearing strength is directly related to the unidirectional strength of the composite, and therefore systems with a higher fiber strength should yield a higher bearing strength. 2 figs., 1 tab.

19954 (UCRL–101922) **^{13}C NMR investigation of crosslinking in organic aerogels.** Ward, R.L.; Pekala, R.W. Lawrence Livermore National Lab., CA (USA). 15 Sep 1989. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900480–1: Symposium on frontiers of polymer characterization by NMR spectroscopy, Boston, MA (USA), 22-27 Apr 1990). Order Number DE90002972. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Organic aerogels are a special type of low density foam produced from the supercritical drying of resorcinol-formaldehyde (RF) gels. These aerogels have continuous porosity, ultrafine cell/pore sizes (<1000 Å), and a microstructure composed of interconnected colloidal-like particles with diameters ranging from 30-175 Å. The particle size, surface area, density, and mechanical properties of the aerogels are largely determined by the catalysts concentration used in the sol-gel polymerization. In order to gain some insight into the crosslinks between RF particles, aerogels were labeled with C-13 formaldehyde at various times in the polymerization. CP-MAS and IRCP techniques were used to correlate the relaxation behavior of the C-13 enriched aerogels with their different microstructures. 9 refs., 1 fig., 2 tabs.

19955 High voltage considerations for silicon-on-insulator devices using porous silicon. Guilinger, T.R. (Sandia National Labs., Albuquerque, NM (USA)); Kelly, M.J.; Tsao, S.S.; Christensen, T.M.; Schubert, W.K. pp. 935 of The Electrochemical Society Spring meeting (extended abstracts). The Electrochemical Society, Pennington, NJ (1989). DOE Contract AC04-76DP00789. (CONF-890518–: 175. meeting of the Electrochemical Society, Los Angeles, CA (USA), 7-12 May 1989).

In this paper the authors describe a device isolation scheme for oxidized porous silicon (OPS) which would be suitable for high voltage BICMOS. They investigate some properties of OPS, such as breakdown strength and etch rate, which affect its usefulness for high voltage IC's.

19956 Phase stability and band structure of the semimagnetic Cd_{1-x} Mn_xTe semiconductor alloy. Wei, S.H. (Solar Energy Research Inst., Golden, CO (USA)); Zunger, A. pp. 572 of Ternary and multinary compounds. Deb, S.K.; Zunger, A. Materials Research Society, Pittsburgh, PA (1987). DOE Contract AC02-77CH00178. (CONF-8609160–: 7. international conference on ternary and multinary compounds, Snowmass, CO (USA), 10-12 Sep 1986).

Spin-polarized, self-consistent local spin density total energy and band structure calculations have been performed for $Cd_{1-x}Mn_xTe$ alloy and its binary constituents in various phases. The authors discuss the phase stability and unusual electronic structure of this semimagnetic semiconductor.

19957 Atomic imaging and microanalysis photovoltaic semiconductor surfaces and interfaces. Kazmerski, L.L. (Solar Energy Research Inst., Golden, CO (USA)). pp. 1671 of Twentieth IEEE photovoltaic specialists conference, 1988. IEEE Service Center, Piscataway, NJ (1988). DOE Contract AC02-83CH10093. (CONF-880965–: 20. IEEE photovoltaic specialists conference, Las Vegas, NV (USA), 26-30 Sep 1988).

The techniques for chemical, compositional and structural analysis of grain boundaries and other micro-features in polycrystalline photovoltaic semi-conductors are examined. These analyses cover the spatial resolution regime from several hundred microns to single atoms. Several conventional surface analysis methods used for chemical mapping are introduced for comparison of the limitations and interpretation of data, stressing the limits of spatial resolution. The emphasis is on the new and emerging techniques, which provide structural, chemical and bonding information on atomic dimensions. Specifically, recently-developed spectroscopic scanning tunneling microscopy (STM) is discussed in terms of providing complementary diagnostic information. Comparative examples are given for the neutralization of shallow impurities at Si grain boundaries by hydrogen, and the incorporation of oxygen at surfaces and internal defects in $CuInSe_2$.

19958 The optical and structural properties of $CuGaSe_2$ polycrystalline thin films. Albin, D. (Solar Energy Research Inst., Golden, CO (USA)); Tuttle, J.; Goral, J.; Mason, A.; Noufi, R.; Risbud, S.H. pp. 1671 of Twentieth IEEE photovoltaic specialists conference, 1988. IEEE Service Center, Piscataway, NJ (1988). DOE Contract AC02-83CH10093. (CONF-880965–: 20. IEEE photovoltaic specialists conference, Las Vegas, NV (USA), 26-30 Sep 1988).

The optical properties of $CuGaSe_2$ polycrystalline thin films deposited by multi-source evaporation as a function of composition and substrate temperature are discussed in terms of the crystal structure and film morphology. Absorption coefficients were determined from total reflection and transmission measurements between 400 and 800 nm. Absorption humps in the absorption spectra were attributed to valence subband transitions, the magnitudes of which were related to the crystal structure of the films as determined by x-ray diffraction (XRD). Band splitting by crystal field and spin-orbit effects was observed at 1.741 and 1.932 eV in stoichiometric and Cu-rich films which contained mainly tetragonal chalcopyrite material.

19959 Evaluation and characterization of $[ZnSiAs_2]_{1-x}[2GaAs]_x$ and $[CuInSe_2]_{1-x}[2InAs]_x$ for photovoltaic device applications. Hasoon, F.S. (Solar Energy Research Inst., Golden, CO (USA)); AlDouri, A.A.J.; AlFoadi, A.H.A.; Alias, M.F.A.; Swartzlander, A.B.; Abou-Elfotouh, F.A.; Nelson, A.J.; Fisher, R.F.; Dhere, R.G.; Asher, S.E. pp. 1671 of Twentieth IEEE photovoltaic specialists conference, 1988. IEEE Service Center, Piscataway, NJ (1988). DOE Contract AC02-83CH10093. (CONF-880965–: 20. IEEE photovoltaic specialists conference, Las Vegas, NV (USA), 26-30 Sep 1988).

The properties of two alloy-semiconductors, $[ZnSiAs_2]_{1-x}[2GaAs]_x$ and $[CuInSe_2]_{1-x}[2InAs]_x$, are determined for potential photovoltaic device applications. The methods of preparation and processing of single-crystals are reported. Compositional, structural, chemical and electro-optical parameters are documented. Some emphasis is placed on the properties of the x = 0.5 materials, which have bandgaps of 1.88 and 0.80 eV for $[ZnSiAs_2]_{0.5}[2GaAs]_{0.5}$ and $[CuInSe_2]_{0.5}[2InAs]_{0.5}$, respectively. Preliminary data on $CdS/[ZnSiAs_2]_{0.5}[2GaAs]_{0.5}$ cell structures are presented to demonstrate the device feasibility of this semiconductor.

19960 Control of deposition and surface properties of $CuInSe_2$ thin films for solar cells. McCandless, B.E. (Delaware Univ., Newark, DE (USA). Inst. of Energy Conversion); Birkmire, R.W. pp. 1671 of Twentieth IEEE photovoltaic specialists conference, 1988. IEEE Service Center, Piscataway, NJ (1988). (CONF-880965–: 20. IEEE photovoltaic specialists conference, Las Vegas, NV (USA), 26-30 Sep 1988).

The authors describe the surface characteristics of $CuInSe_2$ films deposited in two layers by vacuum evaporation using elemental sources controlled by deposition conditions or modified by postdeposition etching. With the first layer substrate temperature less than 350°C the height of growth defects is reduced to less than 3 μm. For composite films where the Cu content exceeds 26%, the surface morphology has an angular faceted structure which may be associated with the onset of a second, Cu_2Se, phase. $CuInSe_2$/(CdZn)S devices fabricated on these films have poor diode characteristics. Specular $CuInSe_2$ films can be produced by etching in a bromine in water solution.

19961 Characterization of $CuInSe_2$ single crystals for solar cell modeling studies. Abou-Elfotouh, F.A. (Solar Energy Research Inst., Golden, CO (USA)); Kazmerski, L.L.; Coutts, T.J.; Dunlavy, D.J.; Almassari, M.; Chaudhuri, S.; Berkmire, R.W. pp. 1671 of Twentieth IEEE photovoltaic specialists conference, 1988. IEEE Service Center, Piscataway, NJ (1988). DOE Contract AC02-83CH10093. (CONF-880965–: 20. IEEE photovoltaic specialists conference, Las Vegas, NV (USA), 26-30 Sep 1988).

The behavior of the (CdZn)S/$CuInSe_2$ solar cell has been numerically analyzed and the known material parameters were imposed to predict attainable performances for this device type. Single crystals of p-type $CuInSe_2$ were characterized and used to fabricate heterojunction solar cells of the form n-(Cd,Zn)S/p-$CuInSe_2$. The experimental and computed performance data were compared. Photoluminescence measurements have also been performed to determine the dominant electrically-active defect states in p-type crystals with simultaneously high carrier concentrations and high carrier mobilities. An energy band diagram of this material is proposed.

19962 Ionization entropy and charge-state-controlled metastable defects in semiconductors. Branz, H.M. (Solar Energy Research Institute, Golden, Colorado 80401 (US)); Crandall, R.S. *Applied Physics Letters (USA),* 55(25): 2634-2636 (18 Dec 1989). DOE Contract AC02-83CH10093.

We propose a new theory of entropy-driven, charge-state-controlled metastability in semiconductors. The entropy change due to metastable defect ionization near 300 K reduces the Gibbs free energy by up to 0.1 eV. This affects equilibrium populations of the various defect charge states and configurations. An example is found in the experiment of Hamilton, Peaker, and Pantelides [Phys. Rev. Lett. **61**, 1679 (1988)] in which a deep level transient spectroscopy signal suddenly disappears during cooling when the ionization entropy term causes a defect's stable local energy minimum to become metastable.

19963 Photoinduced Currents in PZT Thin Films. Butler, M.A. (Sandia National Laboratories, Microsensor Division, Albuquerque, New Mexico 87185 (US)); Martin, S.J.; Land, C.E. *Applied Optics (USA),* 28(23): 5105-5109 (1 Dec 1989). DOE Contract AC04-76DP00789.

The photoinduced currents in a 0.5-μm thick PZT films have been measured as a function of wavelength and poling direction for films on a platinum base electrode and with either aluminum or gold semitransparent top electrodes. Photocurrents display an Urbachlike, exponential dependence on photon energy with additional features relating to interference effects within the film. Transport of the photoexcited carriers is dominated by traps, resulting in a small overall collection efficiency.

19964 Preparation of BaF_2 films by metalorganic chemical vapor deposition. Singh, R. (School of Electrical Engineering and Computer Science, University of Oklahoma, Norman, Oklahoma 73019 (USA)); Sinha, S.; Chou, P.; Hsu, N.J.; Radpour, F.; Ullal, H.S.; Nelson, A.J. *Journal of Applied Physics (USA),* 66(12): 6179-6181 (15 Dec 1989). DOE Contract AC02-83CH10093.

To date thin films of II(a) fluorides (CaF_2, BaF_2, SrF_2, and their mixtures) have only been deposited by physical vapor deposition techniques. We report for the first time the deposition of BaF_2 films on silicon and yttrium-stabilized zirconia substrates by metalorganic chemical vapor deposition at a substrate temperature as low as 400 °C.

19965 Molecular-dynamics studies of the growth modes and structure of amorphous silicon films via atom deposition. Luedtke, W.D. (School of Physics, Georgia Institute of Technology, Atlanta, Georgia 30332-0430 (US)); Landman, U. *Physical Review [Section] B: Condensed Matter (USA),* 40(17): 11733-11746 (15 Dec 1989).

The growth modes of amorphous silicon (*a*-Si) films via vapor-phase and low-energy molecular-beam epitaxy are investigated with use of molecular-dynamics simulations. In these simulations, realistic interatomic interaction potentials, which include two- and three-body interactions, are employed. The dependencies of the growth mechanism and structure of the grown amorphous film on the method of deposition are investigated. For deposition normal to a (111) crystalline Si substrate, a uniform *a*-Si film is generated. Deposition using a beam directed at 60° from the normal to the substrate results in preferential orientation of density inhomogeneities corresponding to a columnar microstructure in the film, while deposition where the impinging particles arrive at random directions to the substrate yields an *a*-Si film containing microvoids. The structural characteristics of the amorphous material and of the interface between the crystal and the amorphous film are analyzed.

19966 Synchrotron photoemission studies of the Sb-passivated Si surfaces: Degenerate doping and bulk band dispersions. Rich, D.H. (Department of Physics, University of Illinois at Urbana-Champaign, 1110 West Green Street, Urbana, Illinois 61801 (US)— Materials Research Laboratory, University of Illinois at Urbana-Champaign, 104 South Goodwin Avenue, Urbana, Illinois 61801) *Physical Review [Section] B: Condensed Matter (USA),* 40(17): 11804-11816 (15 Dec 1989). DOE Contract AC02-76ER01198.

Synchrotron photoemission of the Sb-covered Si(001), Si(111), and Si(110) surfaces revealed that the Fermi-level position crosses the conduction-band minimum (CBM) of Si for Sb coverages approaching a one-monolayer saturation limit. Momentum-resolved photoemission of the Sb-saturated Si(001) and Si(110) surfaces showed the existence of an occupied initial state located near the CBM. The photoemission intensity of the state has been examined as a function of photon energy with constant initial-state difference spectroscopy which showed various resonances occurring due to transitions to different final states from the CBM. The metallic character of the surface is shown to be due to degenerate doping in the near-surface region. Core-level spectroscopy of Sb/Si(111) and Sb/Si(001) revealed that the Si atoms in the near-surface region are converted to exhibit a bulklike arrangement after Sb coverage. The Sb saturation of Si(111) and Si(001) was found to allow the measurement of the bulk band-dispersion relations along the high-symmetry Γ-Λ-L and Γ-Δ-X directions over a wide photon-energy range (37–153 eV). Strain-reduction mechanisms in the near-surface region are discussed. The measured CBM-state resonances and the Si(001) bulk band transitions indicate that the effective mass of the free-electron-like final band changes for varying photon energies.

19967 First-principles calculation of the elastic constants of AlAs. Chetty, N. (University of Illinois, Department of Physics, 1110 West Green Street, Urbana, Illinois 61801 (US)); Munoz, A.; Martin, R.M. *Physical Review [Section] B: Condensed Matter (USA),* 40(17): 11934-11936 (15 Dec 1989).

We use an *ab initio* pseudopotential method within the local-density approximation to determine the full set of elastic moduli of AlAs which have not been directly established experimentally. We find C_{11}=1.16, C_{12}=0.55, and C_{44}=0.57 Mbar, close to those known for GaAs. Since similar calculations for GaAs and other materials produce results in close agreement with experiment, we conclude that our results for AlAs are also reliable.

19968 Dimer strings, anisotropic growth, and persistent layer-by-layer epitaxy. Tsao, J.Y. (Sandia National Laboratories, Albuquerque, New Mexico 87185-5800 (USA)); Chason, E.; Koehler, U.; Hamers, R. *Physical Review [Section] B: Condensed Matter (USA),* 40(17): 11951-11954 (15 Dec 1989). DOE Contract AC04-76DP00789.

We propose that molecular-beam epitaxy of Si on Si(001) can proceed by nucleation and anisotropic growth of dimer "strings." Such anisotropic growth, which changes orientation from layer to layer, imposes topological constraints of growth and can explain recently observed, puzzlingly persistent oscillations in surface diffraction intensities. We speculate that a complete picture for such epitaxy can be based on strings, coupled with an understanding of nucleation rules at steps and on terraces.

19969 Search for thermally generated monovacancies in silicon using monoenergetic positrons. Throwe, J. (Brookhaven National Laboratory, Upton, New York 11973 (US)); Leung, T.C.; Nielsen, B.; Huomo, H.; Lynn, K.G. *Physical Review [Section] B: Condensed Matter (USA),* 40(17): 12037-12040 (15 Dec 1989). DOE Contract AC02-76CH00016.

Using a monoenergetic, variable-energy positron beam, measurements of Doppler broadening and positronium fraction for positron-annihilation radiation from high-resistivity silicon have been made up to the melting point. The measurements show no clear evidence of positron trapping into thermally generated monovacancies which Dannefaer, Mascher, and Kerr observed by measuring the lifetimes of positrons emitted by an *in situ* source. A lower limit of about 3.6 eV is placed on the formation enthalpy of a neutral monovacancy, subject to assumptions about positron-trapping rate, binding energy, and monovacancy formation entropy.

19970 Characterization of microvoids in device-quality hydrogenated amorphous silicon by small-angle x-ray scattering and infrared measurements. Mahan, A.H. (Solar Energy Research Institute, 1617 Cole Boulevard, Golden, Colorado 80401 (USA)); Williamson, D.L.; Nelson, B.P.; Crandall, R.S. *Physical Review [Section] B: Condensed Matter (USA)*, 40(17): 12024-12027 (15 Dec 1989). DOE Contract AC02-83CH10093.

The size, shape, and number density of microvoids in device-quality glow discharge deposited hydrogenated *a*-Si has been obtained by small-angle x-ray scattering (SAXS). By combining the SAXS results with infrared measurements, we deduce that the interior surfaces of these microvoids are largely unhydrogenated, containing at most 4–9 bonded H atoms. We suggest that these H atoms are the clustered H atoms previously detected by multiple-quantum NMR.

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19971 (DOE/ER/10984–T5) **Activities under the oversight of the board on chemical sciences and technology: 1986–1989: Appendix 1, Final report.** National Academy of Sciences - National Research Council, Washington, DC (USA). [1990]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract FG01-81ER10984. Order Number DE90007401. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This report briefly lists activities under the oversight of the board on chemical sciences and technology. This document also contains a list of the current board members. (JDL)

4001 Analytical and Separations Chemistry

Refer also to citation(s) 19192, 19304, 19315, 19317, 19318, 19319, 19320, 19321, 19363, 19829, 20003, 20126, 20357, 20410, 20609, 20648, 20941, 20958

19972 (IPEN-PUB–270) **Characterization of monel alloys by X-ray fluorescence technique.** Scapin, M.A. (Coordenadoria para Projetos Especiais, Sao Paulo, SP (Brazil)); Salvador, V.L.R. Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo, SP (Brazil). Oct 1989. 25p. (In Portuguese). Order Number DE90617175. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Method for the determination of Ni, Cu, Fe, Mn, Si, Al, Ti, Co, Cr and Mo in Monel alloys using thin film for sample preparation and X-ray fluorescence techniques is described. Samples in filings form were completely dissolved with inorganic acids and they were made up to a known volume. Then, these samples were deposited in a filter paper, reducing in this form the effect of the matrix. For all elements the first order emission K_{alpha} lines were selected for measurements and for excitation a rhodium X-ray tub was utilized. For the heavier elements the LiF (200). (author).

19973 (IPEN-PUB–272) **Stannous ion determination in ^{99m}Tc - radiopharmaceutical kits.** Almeida, M.A.T.M. de; Silva, C.P.G. da. Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo, SP (Brazil). Oct 1989. 9p. Order Number DE90617176. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Two simple and selective methods for determination of stannous ion in radiopharmaceutical kits are proposed. One of this permits the estimation of stannic ion. The first method used is a potentiometric tiration of Sn^{+2} in HCl medium using KIO_3 solution under nitrogen gas and a redox platinum electrode. The second method consist of a complexim etric tiration of tin (Sn^{+2} and Sn^{+4}) using EDTA standart solution at pH 5.5-5.6 without use of nitrogen gas. The employed procedures indicates that both the methods can be used for routine quantitative determination of tin in most labeled radiopharmaceuticals. (author).

19974 (IPEN-PUB–275) **Analysis of impurities at trace levels in metallic niobium by instrumental neutron activation analysis.** Favaro, D.I.T.; Vasconcellos, M.B.A.; Santos, C. Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo, SP (Brazil). Oct 1989. 15p. (In Portuguese). Order Number DE90617177. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The interest in obtaining niobium of high purity has increased due to the recent applications of this material in both vacuum and high temperature technologies and to its potential uses in the aeronautic and aerospacial industries and in the nuclear energy field. In the present work, a procedure of analysis of impurities in the parts per million level, in eletrolitic and non-eletrolitic niobium samples has been established. The method of neutron activation analysis followed by high resolution gamma ray spectrometry has been used. The elements Al, Na, Mn, Cl and In, in ppm level and Y, in the percentage level, were determined after irradiation from 1 to 20 minutes, under a thermal neutron flux of 10^{11} $n.cm^{-2}.s^{-1}$ at the IEA-RI reactor of the IPEN-CNEN/SP. The gamma-rays from the radioactive products were measured with a Ge(Li) detector coupled to a 4096 channel analyzer. The elements Ta, Cr and W, in the parts per million level, were determined with irradiation of 8 hours under a thermal neutron flux of 10^{12} $n.cm^{-2}.s^{-1}$. (autor).

19975 (KFK–4634) **Stripping voltammetry of technetium using a TOA modified carbon paste electrode.** Ruf, H.; Schorb, K. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Radiochemie. Oct 1989. 22p. (In German). Order Number DE90753279. Available from NTIS (US Sales Only), PC A03/MF A01.

Low concentrations of technetium have been measured DP-stripping-voltammetrically using a carbon paste electrode modified with tri-n-octylamine (TOA-CPE). Preconcentration of the metal ion on the electrode surface accomplished by dipping of the latter in the sample solution which is 2M in HCl, relies on the chemical reaction with the amine acting as a liquid anion exchanger. Both, Tc-IV occurring as the $TcCl_6^{2-}$ ion in chloride solutions as well as Tc-VII hereby are deposited. Measurements following deposition yield voltammograms of essentially different shapes for the two Tc species. With Tc-IV a characteristic curve with a prominent current signal at -280 mV (vs. Ag/AgCl) is obtained which can be evaluated for Tc quantitation. However, starting from Tc-VII, complex voltammograms are registered not allowing direct technetium assays. Nevertheless, after reduction to Tc-IV, e.g. by means of ascorbic acid, also Tc-VII can be quantified reliably by the method described, the lower detection limit for both oxidation states being about $4x10^{-8}$ M. (orig.).

19976 (KFK–4639) **Stripping voltammetry of technetium in the tetraphenylarsoniumchloride-chloroform extract at the hanging mercury drop electrode.** El-Reefy, S.; Ruf, H.; Schorb, K. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Radiochemie. Nov 1989. 15p. (In German). Order Number DE90753509. Available from NTIS (US Sales Only), PC A03/MF A01.

With the aim of selective stripping voltammetric determination of technetium traces, the radioelement in its +7 state has been separated from interfering substances by solvent extraction with 0.01M tetraphenylarsoniumchloride/chloroform prior to the electroanalytical measurement. In order to avoid back extraction enrichment at the hanging mercury drop electrode (HMDE) by application of a deposition voltage of about -1.6 V (vs. Ag/AgCl), as well as DP cathodic stripping voltammetry has been carried out in the chloroform phase which was made alkaline by the addition of 0.5M sodium hydroxide solution and ethanol as a solubility mediating agent. With the applied composition of the measuring solution (chloroform : 0.5M NaOH : ethanol = 1:0,25:1,6) as well developed current signal at -0.26 V (vs. Ag/AgCl) has been observed. For evaluation of the sampled data according to the standard addition method, standard technetium amounts are directly added to the organic phase. This is allowed, due to the fact that technetium extraction from aqueous sample solution is practically complete. The detection limit was found to be $3x10^{-8}$M Tc. After oxidation to Tc-VII, also technetium originally present as Tc-IV can be extracted and quantified by this way. (orig.).

19977 (LBL–27911) **Measuring chlorinated hydrocarbons in combustion using FTIR spectroscopy.** Lucas, D. (Lawrence Berkeley Lab., CA (USA)); Taga, K.; Hall, M.J.; Koshland, C.P. Lawrence Berkeley Lab., CA (USA). Oct 1989. 69p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-8910289–5: Western States Section meeting of the Combustion Institute, Livermore, CA (USA), 23-24 Oct 1989). Order

Number DE90007407. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

We have recently begun a study of the thermal destruction of toxic wastes. One of the goals of the project is to develop methods for the measurement of species important in the combustion of chlorinated hydrocarbons. We are investigating the use of infrared absorption spectroscopy for this purpose, with emphasis on Fourier-transform infrared spectroscopy (FTIR) coupled with long path length cells. This combination should permit the simultaneous quantitative determination of a large number of compounds, in particular simple C_1 and C_2 chlorinated hydrocarbons. We have obtained infrared spectra for a number of chlorinated species, and for the expected products of their pyrolysis and oxidation. We have determined effects of resolution, pressure, temperature, and gas composition on the resulting spectra, and have determined sensitivity limits, pressure broadening, and instrument linearity for several species. Spectra of products from our combustion driven flow reactor have also been measured. Samples are withdrawn through stainless steel probes and transferred to the long path cell maintained at 100 torr to prevent water condensation. Ethyl chloride (C_2H_5Cl) is injected into the products of a premixed propane-air flame through four quartz injectors. In a separate experiment we have determined that less than 5% of the ethyl chloride reacts in the injectors before mixing with the hot products. 25 figs., 4 tabs.

19978 (PB–90-854449/XAB) **Water chemistry: Analysis for heavy metals. June 1983-May 1987 (Citations from the Selected Water Resources Abstracts data base). Report for June 1983-May 1987.** National Technical Information Service, Springfield, VA (USA). Dec 1989. 97p. Available from NTISPC N01/MF N01.

See also PB–90-854456.

This bibliography contains citations concerning water-quality parameters of on-stream and off-stream sites with specfic reference to heavy-metal contamination. Methods for individual and simultaneous multi-element determinations are discussed. Interference effects and methods to minimize these effects are explained. The ecological consequences of heavy-metal contamination are also presented. (This updated bibliography contains 164 citations, none of which are new entries to the previous edition.)

19979 (PB–90-854456/XAB) **Water chemistry: Analysis for heavy metals. June 1987-December 1989 (Citations from the Selected Water Resources Abstracts data base). Report for June 1987-December 1989.** National Technical Information Service, Springfield, VA (USA). Dec 1989. 100p. Available from NTISPC N01/MF N01.

Supersedes PB–87-861035. See also PB–90-854449.

This bibliography contains citations concerning water-quality parameters of on-stream and off-stream sites with specfic reference to heavy metal contamination. Methods for individual and simultaneous multi-element determinations are discussed. Interference effects and methods to minimize these effects are explained. The ecological consequences of heavy-metal contamination are also presented. (This updated bibliography contains 151 citations, all of which are new entries to the previous edition.)

19980 (PB–90-854506/XAB) **Ion-exchange resins. January 1988-November 1989 (Citations from the COMPENDEX data base). Report for January 1988-November 1989.** National Technical Information Service, Springfield, VA (USA). Dec 1989. 137p. Available from NTISPC N01/MF N01.

Supersedes PB–89-852883.

This bibliography contains citations concerning preparation, properties, and applications of ion-exchange resins. Applications include water and waste treatment; chemical recovery, separation, purification, and catalysis; desalination; and ore treatment and recovery. Regeneration and disposal of ion-exchange resins are also covered. (This updated bibliography contains 266 citations, 92 of which are new entries to the previous edition.)

19981 American Chemical Society, 75 years of progress, Division of Environmental Chemistry, preprints of papers. 514p. American Chemical Society, Washington, DC (US) (1988). (CONF-8909264–: Conference of the Chemical Coal Upgrading Department on fundamentals and processes of pyrolysis and coking, Essen (Germany, F.R.), 6-8 Sep 1989).

The 196th ACS meeting was held in the Los Angeles September 25-30, 1988. The Division of Environmental Chemistry presented symposia on the following topics: data analysis procedures for trace constituents and toxic compounds, photochemical oxidants and their precursors, ionizing radiation in drinking water, environmental chemistry of dyes, biogeochemistry of CO_2 and the greenhouse effect, and biological markers of environmental contaminants. Abstracts are included for 151 papers.

19982 Extractions with a carbamoylmethyl phosphonate functionalized polymer. Blaha, S.L. (New Mexico Univ., Albuquerque (USA). Dept. of Chemistry (USA)); Claudle, L.J.; Conary, G.C.; Paine, R.T.; Thomas, K.W. *Radiochimica Acta (Germany, F.R.)*, 48(1/2): 59-64 (1989). DOE Contract AS04-82ER40079.

Diethyl-N,N-diethylcarbamoylmethyl phosphonate was covalently immobilized on polystyrene-divinyl benzene copolymer at the methyl carbon atom in the ligand backbone, and the ability of this functionalized polymer to extract Ce, Eu and Yb from selected aqueous acid solutions was characterized. (orig.).

19983 U-Pb baddeleyite ages for the Scourie dyke swarm, Scotland: evidence for two distinct intrusion events. Heaman, L.M. (Royal Ontario Museum, Toronto (Canada). Dept. of Geology); Tarney, J. *Nature (London) (UK)*, 340(6236): 705-708 (31 Aug 1989).

Precambrian dyke swarms, such as the Scourie dyke swarm in North-west Scotland, are invaluable time-markers, so that a precise and accurate knowledge of their emplacement age is critical when unravelling the complex geological evolution of many terrains. Precise dating is often difficult, however, because magma interaction with country rock and subsequent metamorphic events can severely perturb some isotopic systems. Recent advances in U-Pb geochronology combined with the discovery that some mafic dykes contain trace amounts of uranium-bearing minerals such as baddeleyite (ZrO_2) and/or zircon have made it possible to obtain U-Pb ages for these rocks with a precision typically on the order of 1-2 Myr. Here we report the results from a U-Pb study of three members of the Scourie dyke swarm, and find at least two periods of dyke emplacement at 2,418 and 1,992 Myr BP. (author).

19984 Optical absorption measurement system. Draggoo, V.G.; Morton, R.G.; Sawicki, R.H.; Bissinger, H.D. To Dept. of Energy, Washington, DC. USA Patent 4,868,768. 19 Sep 1989. Filed date 17 Sep 1986. USA Patent Application 6 908,482. Int. Cl. G01J 5/08. 8p. Available from Patent and Trademark Office, Box 9, Washington, DC 20232.

This patent describes a non-intrusive method for measuring the temperature rise of optical elements under high laser power optical loading to determine the absorption coefficient. The method comprises irradiating the optical element with a high average power laser beam, viewing the optical element with an infrared camera to determine the temperature across the optical element and calculating the absorption of the optical element from the temperature.

19985 Separation of actinides from lanthanides. Smith, B.F.; Jarvinen, G.D.; Ryan, R.R. To Dept. of Energy, Washington, DC. USA Patent 4,867,951. 19 Sep 1989. Filed date 31 Mar 1988. USA Patent Application 7 176,131. Int. Cl. C01F 17/00; C07F 5/00; C01G 56/00. 8p. Available from Patent and Trademark Office, Box 9, Washington, DC 20232.

This patent describes an organic extracting solution and an extraction method useful for separating elements of the actinide series of the periodic table from elements of the lanthanide series, where both are in trivalent form. The extracting solution consists of a primary ligand and a secondary ligand, preferably in an organic solvent. The primary ligand is a substituted monothio-1,3-dicarbonyl, which include a substituted 4-acyl-2-pyrazolin-5-thione, such as 4-benzoyl-2,4-dihydro-5-methyl-2-phenyl-3H-pyrazol-3-thione (BMPPT). The secondary ligand is a substituted phosphine oxide, such as trioctylphosphine oxide (TOPO).

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Refer also to citation(s) 19183, 19184, 19188, 19192, 19196, 19197, 19272, 19273, 19474, 19513, 19628, 19629, 19906, 19948, 20013, 20045, 20047, 20048, 20103, 20830

19986 (AD-A-214010/1/XAB) **Tunnelling effects on low-energy fusion cross sections. Special report, June-August 1989.** Leakeas, C.L. Air Force Astronautics Lab., Edwards AFB, CA (USA). Sep 1989. 18p. (AL-TR-89-053). Available from NTIS, PC A03/MF A01.

Recently, the claim of discovery of cold fusion among the isotopes of hydrogen in a metal lattice has raised many questions as to the cross sections of some fusion reactions at low energies. This report investigates the quantum phenomenon of tunneling and its effects on the fusion process. Special attention is paid to penetrabilities in the Hulthen potential, which gives a reasonably accurate approximation of the potential inside the metal lattice. This report includes cross section data for the DD, DT and pD reactions. Also given are graphs showing the fusion cross section crossover point between the DD and DT reactions and the increased penetrabilities due to enhance tunneling effects.

19987 (CONF-900402-4) **Activation of methane by transition metal-substituted aluminophosphate molecular sieves.** Maroni, V.A.; Willms, K.A.; Nguyen, Hiephoa; Iton, L.E. Argonne National Lab., IL (USA). Dec 1989. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 199. national meeting of the American Chemical Society; Boston, MA (USA); 22-27 Apr 1990. Order Number DE90005663. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Recent experiments in our laboratory have demonstrated that aluminophosphate molecular sieves substituted with cobalt and cobalt/silicon combinations and having the $AlPO_4$-34 or $AlPO_4$-5 structure activate methane starting at ~350°C. Between 400 and 500°C the rate of methane conversion increases steadily with typical conversion efficiencies at 500°C ranging from 15 to 60%. The cobalt and silicon substituted $AlPO_4$-34 structure (CoAPSO-34) produces ethylene, ethane, propylene, and propane in varying proportions, depending on reactions conditions. The cobalt-substituted $AlPO_4$-5 (CoAPSO-5) produces propylene in very high yield with ethane, ethylene, and propane also seen. Analogous aluminophosphate molecular sieves substituted with magnesium or silicon, but containing no transition metal (e.g., SAPO-34, MAPO-5), do not activate methane under the conditions described above. The activation mechanism is based on reduction of the cobalt(III) form of the molecular sieve to the cobalt(II) form with accompanying oxidative dehydrogenation of the methane. Reoxidation of the cobalt(II) for to the cobalt(III) form can be done either chemically (e.g., using O_2) or electrochemically. 7 refs., 2 figs., 1 tab.

19988 (DOE/ER/13647-T3) **[Competitive ion kinetics in direct mass spectrometric organic speciation]: Progress report.** National Bureau of Standards, Gaithersburg, MD (USA). [1990]. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AI01-87ER13647. Order Number DE90007426. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Essentially all of the completed/in progress studies during the last reporting period have involved the NIST pulsed electron beam high pressure mass spectrometer. Three distinct areas of research are recognizable; (i) determinations of binding energies and entropies for association and cluster ions, which is accomplished by measuring the temperature dependence of the equilibrium A^+ or A^- + B ↔ A^+·B or A^-·B, (ii) measurement of the temperature dependence of biomolecular rate constants and unimolecular rate constants for the thermal decomposition (pyrolysis) of protonated organic molecules, and (iii) evaluation of proton affinities and gas phase acidities via measurement of variable-temperature equilibria of the type AH^+ + B ↔ BH^+ + A and A^- + BH ↔ AH + B^-. The various systems and classes of molecules chosen for study were those deemed most likely to provide fundamental new information on ion kinetics, ionic stabilities and ionic reaction mechanisms. The key results of some representative projects are summarized.

19989 (DOE/ER/13825-2) **Thermodynamics of systems with very many components phase equilibrium: Progress report.** Glandt, E.D. Pennsylvania Univ., Philadelphia, PA (USA). Dept. of Chemical Engineering. Oct 1989. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-88ER13825. Order Number DE90007345. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report covers the activities sponsored at the University of Pennsylvania under Contract No. FG02-87ER13825. The following is a summary of the main points: The semigrand canonical formalism was developed. This is a new and very efficient method for the determination of phase diagrams to any class of mixtures by computer simulation, equally efficient for any number of components, has been demonstrated for binaries. This approach also allows the calculation of phase equilibrium at much higher densities than could be reached before. Density functional theory is a state-of-the-art technique for the study of non-uniform liquids. It relates the properties of fluids in an external field to those of fluids in a different field. All previous work on mixtures, including those of very many components, was tacitly based on the assumption that the components were not too different, or that the "cut" was narrow. We have for the first time addressed the opposite case, when the components are extremely dissimilar. We have developed the rather novel and very useful concept of "infinitely polydisperse" mixtures. A theoretical study of the effect of polydispersity on solid-liquid equilibrium. SLE is the single phenomenon most strongly affected by polydispersity, since the presence of even small amounts of an extraneous component can disrupt, and even completely preclude, crystallization. 22 refs., 3 figs.

19990 (DOE/ER/45120-10) **Systematic preparation of selective heterogeneous catalysts: Progress report, September 1, 1984-February 15, 1990.** Augustine, R.L. Seton Hall Univ., South Orange, NJ (USA). Dept. of Chemistry. 23 Feb 1990. 27p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-84ER45120. Order Number DE90007185. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The single turnover (STO) active site characterization technique was developed to provide data on active site densities on dispersed metal catalysts. This technique has been applied to Pt, Pd, and Rh metals supported on CPG, SiO_2, TiO_2, and Al_2O_3. In all cases the densities of the two or three saturation sites present on the catalyst can be measured if appropriate care is taken to avoid diffusion control of the reaction sequence. Isomerization site densities cannot be determined, however, because of the non-stoichiometry of the isomerization reaction. Series of these catalysts have been used in studying various catalytic processes in order to evaluate the nature of the active site(s) involved. Modifier:catalyst interactions are also being studied using these STO characterized materials. This research program is being extended to the study of organometallic reactions run over metal surfaces and the development of Frontier Molecular Orbital calculations for the various types of surface sites present on a metal to provide a theoretical basis for the development of new catalytic reactions. The overall goal of this research has been to develop a sufficiently detailed understanding of heterogeneous catalysis so the synthetic chemist can routinely use heterogeneously catalyzed processes for the preparation of fine chemicals and pharmaceuticals. 41 refs., 6 figs., 2 tabs.

19991 (IPEN-PUB-193) **Establishment of a radiochemical procedure for the obtainment strontium titanate.** Cunha, I.I.L.; Andrade e Silva, L.G. de. Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo, SP (Brazil). Aug 1988. 12p. (In Portuguese). Order Number DE90617311. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A research that aims to develop radiochemical procedures for the separation and solidification of ^{137}Cs and ^{90}Sr from fission products solutions has been carried out at the Radiochemistry Division of IPEN-CNEN/SP. In a previous paper[1], a schematic outline of the process steps for the separation of ^{90}Sr from fission products mixture was shown. In the present paper, the experimental conditions for solidification of strontium as strontium titanate have been studied. According to literature data, this compound offers the most suitable chemical form to use ^{90}Sr as beta rays source. (author).

19992 (LA-UR-90-196) **A lattice gas automata model for heterogeneous chemical reactions at mineral surfaces and in pore networks.** Wells, J.T. (Washington Univ., Seattle, WA (USA). Dept. of Geological Sciences); Janecky, D.R.; Travis, B.J. Los Alamos National Lab., NM (USA). 15 Jan 1990. 20p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36.

(CONF-8909298–1: NATO conference, Los Alamos, NM (USA), 6-9 Sep 1989). Order Number DE90006516. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A lattice gas automata (LGA) model is described, which couples solute transport with chemical reactions at mineral surfaces and in pore networks. Chemical reactions and transport are integrated into a FHP-I LGA code as a module so that the approach is readily transportable to other codes. Diffusion in a box calculations are compared to finite element Fickian diffusion results and provide an approach to quantifying space-time ratios of the models. Chemical reactions at solid surfaces, including precipitation/dissolution, sorption, and catalytic reaction, can be examined with the model because solute diffusion and mineral surface processes are all treated explicitly. The simplicity and flexibility of the LGA approach provides the ability to study the interrelationship between fluid flow and chemical reactions in porous materials, at a level of complexity that has not previously been computationally possible. 20 refs., 8 figs.

19993 (OEFZS–4497) **Hydrolitical equilibrium of hydrates of portland cement, part 1.** Komurka, M.; Scheiber, R. Oesterreichisches Forschungszentrum Seibersdorf GmbH (Austria). Inst. fuer Energie- und Anlagentechnik. Mar 1989. 93p. (In German). (EA–333/89). Order Number DE90617280. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

Based on the basic principles of thermodynamics the present report (Part 1) provides a contribution to thermodynamically favoured stable states of the most important hydrated compounds of portland cement. An extensive literature search was made to find the related thermodynamic data for the data-base. According to our calculations even at room temperature the C-S-H-Gel is not the thermodynamically most stable end product of hydrated calcium silicates. The most stable products might be Hillebrandit, Foshagit, 11A Tobermorit or Gyrolit. It is generally agreed, that the cubic hydrate C3AH6 is the stable end product of calcium aluminate hydrates. Our calculations lead to the same results. By sulfates we have found, that at lower temperatures Ettringit is the stable phase, but at higher temperatures the corresponding monosulfate is more stable. Ettringit is not stable relative to C3AH6 even in its water solutions. Ettringit is also not stable relative to Friedl's salt. More information could be found in Part 2 of this report (in preparation). 46 figs., 13 refs., 18 tabs. (Authors).

19994 Reduction in crystal symmetry of a solid solution: A neutron diffraction study at 15 K of the host/guest system asparagine/aspartic acid. Weisinger-Lewin, Y. (Weizmann Institute of Science, Rehovot (Israel)); Frolow, F.; Lahav, M.; Leiserowitz, L.; McMullan, R.K.; Koetzle, T.F. *Journal of the American Chemical Society (USA)*, 111(3): 1035-1040 (1 Feb 1989). DOE Contract AC02-76CH00016.

It has been demonstrated, for the first time by diffraction methods, that a solid solution composed of host and guest molecules can exhibit a crystal symmetry lower than that of the host. The study proves that the symmetry of a solid solution is dependent not only upon the host crystal structure and the guest molecular structure but also upon the surface structure and symmetry of the host crystal. The crystal structures of (S)-asparagine monohydrate ($D_2NCOCH_2CH(ND_3)CO_2 \times D_2O$) and of the solid solution (0.848:0.152) (S)-asparagine/(S)-aspartic acid ($DO_2CCD_2CD(ND_3)CO_2$) monohydrate were refined by using neutron diffraction data obtained at 15 K. The space group of the pure host crystal is $P2_12_12_1$ (Z = 4), whereas that of the host/guest crystal is monoclinic $P12_11$ with two molecular sites per asymmetric unit. The ratios of guest/host occupancies of the two independent sites are 0.173:0.827 and 0.132:0.868. The reduction in symmetry is in accordance with the preferred adsorption of guest aspartic acid on the (010) crystal face at half of the orthorhombic, symmetry-related surface sites. Aspartic acid mimics, at the preferred (010) surface sites, molecular asparagine, participating in all hydrogen bonds. At the less-favored (010) surface sites a normal N-H···O(host) hydrogen bond is replaced by O(hydroxyl)···O(host) repulsion between lone-pair electrons. 21 refs., 5 figs., 6 tabs.

19995 Absolute electronegativity and hardness: Applications to organic chemistry. Pearson, R.G. (Univ. of California, Santa Barbara (USA)). *Inorganic Chemistry (USA)*, 54(6): 1423-1430 (17 Mar 1989).

The recent concepts of absolute electronegativity, χ, and absolute hardness, η, are briefly reviewed. Experimental values for a large number of molecules and radicals are presented. The values are shown to be in good agreement with the known chemical behavior, both as to nucleophilic-electrophilic properties and as to rates of reaction. Applications are also given for the use of empirical rank orders of the local hardness, $\bar{\eta}$. The uses of χ and η are consistent with frontier orbital theory. To make meaningful comparisons in a series of molecules, it is necessary that these orbitals remain the same. Also it is necessary that the observed I and A values of the molecules relate to the appropriate frontier orbitals. 39 refs., 10 tabs.

19996 Temperature-programmed desorption study on NO on Pt particles supported on α-Al_2O_3(0001). Altman, E.I. (Univ. of Pennsylvania, Philadelphia (USA)); Gorte, R.J. *Journal of Physical Chemistry (USA)*, 93(5): 1993-1997 (9 Mar 1989).

The adsorption and dissociation of NO on Pt/α-Al_2O_3(0001) were studied as a function of Pt particle size by using temperature-programmed desorption (TPD). Samples were prepared by vapor depositing varying amounts of Pt onto the substrate at 300 K in vacuum, and the average Pt particle size was estimated from the surface area measured by using the CO adsorption uptake and the amount of metal deposited as measured by a quartz crystal film thickness monitor. On Pt particles larger than 4.0 nm, the results were similar to those obtained on Pt foils and some stepped crystals. More than 80% of the NO that was adsorbed at 300 K dissociated during TPD, with N_2 desorbing in a sharp peak at 460 K. As the particle size decreased, the fraction of NO that dissociated decreased, and a second N_2 peak was observed in TPD at 540 K. This peak at 540 K was the only N_2 desorption feature observed on the smallest particles (<2.0 nm), and only 45% of the NO dissociated during TPD on these samples. Using coadsorption of ^{15}NO with low coverages of CO followed by monitoring CO_2 formation during TPD, we found that the N_2 desorption peaks at both 460 and 540 K are dissociation-rate limited. Therefore, smaller particles appear to be much less active for NO dissociation than larger particles. An additional conclusion of this study is that, although all of the desorption features that were observed are in the temperature range typically observed for bulk Pt metals, the desorption behavior cannot be related to that observed on any simple single-crystal surfaces.

19997 Redetermination of the crystal and molecular structure of tris(bipyridine)chromium(III) hexafluorophosphate. Goodwin, K.V. (Clemson Univ., SC (USA)); Pennington, W.T.; Petersen, J.D. *Inorganic Chemistry (USA)*, 28(10): 2016-2018 (17 May 1989).

During studies of the structures of the complexes $Cr(bpm)_2Cl_2^+$, $Cr(bpm)_3^{3+}$, and $Cr(dpp)_3^{3+}$ (where bpm = 2,2′-bipyridine and dpp = 2,3-bis(2-pyridyl)pyrazine), comparison of their structures to that of $[Cr(bpy)_3](PF_3)_3$ showed differences that could not be rationalized. The structure of the latter compound has been investigated and is reported herein. The results indicate that there was a missed center of symmetry that led to the distorted geometry of the structure previously reported for $[Cr(bpy)_3](PF_6)_3$ resulting from the R32 refinement. Addition of an inversion center midway between the two cations was found to generate a 3 site at (0, 0, 1/4). The model obtained from the R3c refinement was found to have chemically reasonable distances and angles that compare favorably with the geometry observed for $Cr(bpy)_3^{3+}$ cation of a perchlorate salt which co-crystallizes with bipyridinium perchlorate. 9 refs., 1 fig., 3 tabs.

19998 Bimetallic complexes containing the bis(tetramethylcyclopentadienyl)ethane ligand. Buzinkai, J.F. (Massachusetts Institute of Technology, Cambridge (USA)); Schrock, R.R. *Inorganic Chemistry (USA)*, 28(14): 2837-2846 (12 Jul 1989). DOE Contract FG02-86ER13564.

Bimetallic complexes containing one transition metal from early in the series and one from later in the series are of interest as catalysts for the hydrogenation of carbon monoxide at lower temperatures and pressures (generally 200°C and 100-2500 atm). The method of preparation of some homobimetallic (tungsten/tungsten) complexes containing the simpler fully methyl-substituted system,

(η^5-η^5Me_4) $Me_4C_5CH_2CH_2C_5Me_4(Cp^2)$ is described. Compounds in which one ring is bound to tungsten and the other is bound to rhodium or cobalt have been prepared. 24 refs., 3 figs.

19999 **Moessbauer effect determination of chemical segregation in sputtered Co-Cr films.** Parker, F.T. (University of California, San Diego, La Jolla, California 92093 (US)); Oesterreicher, H.; Fullerton, E. *Journal of Applied Physics (USA)*, 66(12): 5988-6000 (15 Dec 1989).

Moessbauer spectroscopy has been used to determine several of the features of sputtered Co-Cr films. Isotopically enriched ^{57}Fe was used as a probe in the films and in bulk alloys employed as calibration standards. Film stoichiometries from 14.5 to 32 at. % Cr were measured. Three phases are observed. For films sputtered at 200 °C substrate temperature, one phase (about 40 at. % of the films) has a composition close to the overall film composition. The second and most accurately determined phase is Co rich, showing increasing Cr concentration and decreasing mole fraction with increasing overall Cr content. For example, a 21.3 at. % Cr film contains a Co-rich phase with 6.0 at. % Cr. The third phase is Cr rich and nonmagnetic. Compositions have been determined indirectly through the film saturation moments. Assuming the Fe:Co ratio is constant in the various phases, the third phase contains about 37 at. % Cr for nearly all overall film compositions, close to the σ-phase boundary. The relative amount of this phase increases with increasing total Cr. Segregation occurs for Cr film concentrations at least as low as 14 at. %. The mechanism of segregation seems to be nucleation and growth rather than spinodal. For perpendicularly oriented films, Moessbauer polarization data show no evidence of in-plane moments. Low-temperature Moessbauer data show negligible temperature-dependent relaxation.

20000 **Dynamics of a lamellar system with diffusion and reaction: Scaling analysis and global kinetics.** Muzzio, F.J. (Department of Chemical Engineering, University of Massachusetts, Amherst, Massachusetts 01003 (US)); Ottino, J.M. *Physical Review [Section] A: General Physics (USA)*, 40(12): 7182-7192 (15 Dec 1989).

The evolution of a one-dimensional array of reactive lamellae with distributed striation thickness is studied by means of simulations, scaling analysis, and space-averaged kinetics. An infinitely fast, diffusion-controlled reaction $A+B \rightarrow 2P$ occurs at the interfaces between striations. As time increases, thin striations are eaten by thicker neighbors resulting in a modification of the striation thickness distribution (STD). Scaling analysis suggests that the STD evolves into a universal form and that the behavior of the system at short and long times is characterized by two different kinetic regimes. These predictions are confirmed by means of a novel numerical algorithm.

4004 Electrochemistry

Refer also to citation(s) 19747, 20012, 20138, 20818

20001 (DOE/ER/13387–70) **Organic redox phototransformations at chemically modified surfaces: Progress report, January 1989–December 1989.** Fox, M.A. Texas Univ., Austin, TX (USA). Dept. of Chemistry. Jan 1990. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-85ER13387. Order Number DE90007418. Available from NTIS, PC A02/MF A01 - OSTI.

This progress report consists of a one page summary and a listing of reports published in 1989. (JL)

20002 (LBL–28076) **Effects of nonuniform potential and current distributions in electrochemical systems.** West, A.C. Lawrence Berkeley Lab., CA (USA). Dec 1989. 216p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90007349. Available from NTIS, PC A10/MF A01 - OSTI; GPO Dep.

We examine the effects that nonuniform current and potential distributions have on electrochemical systems. Chapter 1 provides definitions used by researchers studying these phenomena. In chapter 2, we discuss boundary integral techniques, which are powerful numerical methods used in such studies. In chapters 3 and 4, an asymptotic solution is developed that shows explicitly how the extreme characteristics of a primary current distribution are approached when the ohmic resistance of the cell becomes large compared to the resistance of the faradaic reaction. It is shown how these results can be used to complement and verify more common numerical analyses. Chapters 5 and 6 show how to determine exchange current densities and transfer coefficients when the reaction rate along the electrode is nonuniform. The results can be used to design experiments that provide for a more straightforward interpretation of data. The ohmic resistance and current distribution for a recessed disk electrode are given in chapter 7. Chapter 8 discusses briefly experimental work intended to elucidate whether the dissolution kinetics of ferrous-sulfate films must be included in mathematical descriptions of the complicated dynamic behavior of iron dissolution in sulfuric acid.

20003 (LBL–28085) **An in situ study of the anodic film formation of Cu, Ag, and Zn in alkaline media.** Mayer, S.T.; Muller, R.H. Lawrence Berkeley Lab., CA (USA). Dec 1989. 510p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90007064. Available from NTIS, PC A22/MF A01 - OSTI; GPO Dep.

The anodic film formation of Cu, Ag, and Zn in alkaline solutions was investigated using several in situ as well as ex situ techniques. These included angular resolved elastic light scattering, Raman spectroscopy, spectroscopic ellipsometry, scanning tunneling microscopy, scanning electron microscopy, and x-ray diffraction. A discussion of the apparatus and theory of in situ elastic light scattering and Raman spectroscopy for studying thin-film nucleation and growth is presented. 304 refs., 151 figs., 1 tab.

20004 **A new formulation for image potential energies at the semiconductor - solution interface.** Koval, C.A. (Colorado Univ., Boulder, CO (USA). Dept. of Chemistry and Biochemistry (USA)); Smith, B.B. pp. 935 of The Electrochemical Society Spring meeting (extended abstracts). The Electrochemical Society, Pennington, NJ (1989). (CONF-890518–: 175. meeting of the Electrochemical Society, Los Angeles, CA (USA), 7-12 May 1989).

The semiconductor electrode-electrolyte interface (SEI) has unique properties that result in kinetics for electron transfer processes which differ from those observed at the metal electrode-electrolyte interface (MEI) or in homogeneous systems. Unfortunately, the gap between experiment and theoretical understanding for the SEI is presently large. Existing theories often predict currents that disagree with experiment by many orders of magnitude, even in cases where it is difficult to believe large experimental error exists. Many well-established results from solid-state and surface physics are almost universally neglected in theories describing fundamental properties at solid/electrolyte interfaces. This paper focuses on a SEI energetic parameter that has a much more complex interpretation than is generally attributed to it: the image potential energy for an ion. Reorganization energy calculations, incorporating the image potential, are also presented.

20005 **Dioxygen electrocatalysts on adsorbed layers of transition metal macrocycles.** Yeager, E. (Case Western Reserve Univ., Cleveland, OH (USA). Case Center for Electrochemical Sciences); Gupta, S.L.; Simic-Glavaski, B.; Bae, I.T. pp. 935 of The Electrochemical Society Spring meeting (extended abstracts). The Electrochemical Society, Pennington, NJ (1989). (CONF-890518–: 175. meeting of the Electrochemical Society, Los Angeles, CA (USA), 7-12 May 1989).

A particularly challenging problem in electro-catalysis is the identification of effective catalysts for the reduction of O_2 in aqueous electrolytic solutions at moderate temperatures. Despite over a century of efforts to do such, the presently available catalysts still suffer from very substantial activation overpotential at the current densities used in such applications as fuel cells, metal-air batteries and industrial electrolytic processes. This is true even with very highly dispersed platinum with surface areas of ~150 m^2/g. This need for more effective O_2 electrocatalysts has resulted in much fundamental research interest in this area. Studies are in progress in the authors' laboratory on the factors which control the adsorption and retention of the transition metal macrocycle on various types of electrode surfaces. These factors include types of macrocycles, electrode potential, the type of substrate, the electrolyte

(particularly the anion) and pH. The authors discuss how the surface structure of the self assembled layers is believed to be quite dependent on these various factors.

20006 Catalysis of a photoelectrochemical copper plating reaction by non-thermalized electrons. Koval, C.A. (Colorado Univ., Boulder, CO (USA). Dept. of Chemistry and Biochemistry); Segar, P.R. pp. 935 of The Electrochemical Society Spring meeting (extended abstracts). The Electrochemical Society, Pennington, NJ (1989). (CONF-890518–: 175. meeting of the Electrochemical Society, Los Angeles, CA (USA), 7-12 May 1989).

When a p-type semiconducting electrode is illuminated with photons having energies greater than the band gap, it is generally thought that the excited electrons are thermalized as they travel through the depletion region, ultimately being ejected into the solution at the energy of either the conduction band edge or of surface states within the bandgap. The authors describe how thermalization represents one of the greatest contributions to power loss in photoelectrochemical cells. They discuss their use of an irreversible redox reaction to trap hot electrons produced at the p-InP/acetonitrile interface. $Cu(II)(trans\text{-}diene)^{2+}$ is reversible reduced by one electron to form $Cu(I)(trans\text{-}diene)^{+}$. The Cu(I) complex can be reduced by one more electron at potentials significantly negative of the InP conduction band edge. This irreversible reaction requires significant overpotentials and results in plating of copper metal on the surface of the electrode. Anodically stripping this film is a highly sensitive means of determining the exact amount of Cu(O) product produced via reaction with hot electrons.

20007 Temperature dependence of the ferrous-ferric reaction rate: IV. experimental results and comparison to theory. . Nagy, Z. (Argonne National Lab., IL (USA). Materials Science and Technology Div.); Hung, N.C.; Yonco, R.M. pp. 935 of The Electrochemical Society Spring meeting (extended abstracts). The Electrochemical Society, Pennington, NJ (1989). DOE Contract W-31-109-ENG-38. (CONF-890518–: 175. meeting of the Electrochemical Society, Los Angeles, CA (USA), 7-12 May 1989).

The investigation of the kinetics of electrode reactions in high-temperature/high-pressure aqueous solutions is an experimental challenge, partially because of the extreme conditions and partially because many of the reactions of interest are very rapid. Fast relaxation techniques are needed to measure the kinetics of these reactions, and these measurement techniques impose severe restrictions on the design of the measuring cell and the electrodes. The authors have developed a measuring system which is suitable for measurements of the kinetics of fast electrode reactions using dc relaxation techniques at temperatures extending to at least $300^{0}C$ and pressures to at least 10 MPa. In addition to the novel electrode and cell designs, they also developed numerical data-evaluation methods suitable for fast kinetic measurements and special experimental procedures that eliminate the catalytic effects of trace impurities. Their results are presented in this paper. The working-counter electrode assembly and the reference electrode design are shown.

20008 Temperature dependence of the ferrous-ferric reaction rate: III. molecular dynamics predictions of the reaction rate. . Halley, J.W. (Minnesota Univ., Minneapolis, MN (USA). School of Physics and Astronomy); Hautman, J.; Rhee, Y.J. pp. 935 of The Electrochemical Society Spring meeting (extended abstracts). The Electrochemical Society, Pennington, NJ (1989). (CONF-890518–: 175. meeting of the Electrochemical Society, Los Angeles, CA (USA), 7-12 May 1989).

The authors describe a molecular dynamics calculation of the rate of electron transfer in an outer shell electron transfer reaction at the electrode-electrolyte interface using a model described in the previous talk. The model consists of 216 water molecules in a box together with one iron ion which can be in either its ferrous or its ferric valence state. Long range coulomb interactions are taken into account by use of Ewald methods as described in the previous paper. The algorithm for calculation of the electron transfer rate is reviewed. They report the first results using this algorithm in a calculation which takes account of the long range interactions using Ewald methods. The results are in reasonable accord with experiment.

20009 Temperature dependence of the ferrous-ferric reaction rate: II. molecular dynamics model for the interface. . Hautman, J. (Minnesota Univ., Minneapolis, MN (USA). School of Physics and Astronomy); Halley, J.W. pp. 935 of The Electrochemical Society Spring meeting (extended abstracts). The Electrochemical Society, Pennington, NJ (1989). (CONF-890518–: 175. meeting of the Electrochemical Society, Los Angeles, CA (USA), 7-12 May 1989).

The authors describe a molecular dynamics mode for the electrode-electrolyte interface which is used for calculation of the electron transfer rate. The model consists of 216 water molecules in a box together with one iron ion which can be in either its ferrous or its ferric valence state. They review previous work which establish the validity of the model for the ion in bulk aqueous solution. They describe Ewald methods by which long range coulomb interactions are taken into account and report simulations of the solvent electrode interface using them.

20010 Temperature dependence of the ferrous-ferric reaction rate: I. electronic structure calculations. . Curtiss, L.A. (Argonne National Lab., IL (USA). Chemical Technology Div.); Blerwagen, E. pp. 935 of The Electrochemical Society Spring meeting (extended abstracts). The Electrochemical Society, Pennington, NJ (1989). DOE Contract W-31-109-ENG-38. (CONF-890518–: 175. meeting of the Electrochemical Society, Los Angeles, CA (USA), 7-12 May 1989).

In this paper on electronic structure calculations, the authors present results in three areas of work related to the theoretical modeling of the heterogeneous ferrous-ferric electron transfer. They describe their ab initio molecular orbital investigation into Fe^{2+} and Fe^{3+} interactions with water used to help derive pair potentials for the molecular dynamics simulation of the electrolyte. They report on the adsorption of water on a gold surface based on semi-empirical molecular orbital calculations. This provides guidance for the molecular dynamics simulation of the electrode/electrolyte interface as well as a model for calculation of the electronic interaction of the redox couple which is an important factor in the electron transfer rate. Finally, an investigation of the electronic interaction as represented by the electronic matrix element H_{12} is reported.

20011 Electrocatalysts of chlorine evolution at noble metal-implanted titanium electrodes. Kelly, E.J. (Oak Ridge National Lab., TN (USA). Chemistry Div. (USA)); Heatherly, D.E.; Vallet, C.E.; White, C.W. pp. 935 of The Electrochemical Society Spring meeting (extended abstracts). The Electrochemical Society, Pennington, NJ (1989). DOE Contract AC05-84OR21400. (CONF-890518–: 175. meeting of the Electrochemical Society, Los Angeles, CA (USA), 7-12 May 1989).

In the present report, the results of a study of Cl_2 evolution at Ir-implanted titanium are described and compared to those obtained with $Ru_xTi_{1-x}O_2/Ti$ electrodes. ^{193}Ir was implanted into zone-refined titanium to yield near-Gaussian Ir concentration/depth profiles (determined by RBS) with the peak Ir concentration located at 30-50 nm from the surface. As in the case of the Ru-Ti alloys, the Ir-Ti near surface alloy were anodically oxidized in the solutions of interest to form $Ir_xTi_{1-x}O_2/Ti$ electrodes. Potentiodynamic polarization curves are shown for an unimplanted titanium electrode in 1 M $[Cl^-]$, and for a $Ir_xTi_{1-x}O_2Ti$ electrode in 1 M $[Cl^-]$and in 1 M $[HSO_4^- + SO_4^=]$. The polarization curve for pure titanium shows no evidence for the evolution of either Cl_2 or O_{22}. This result is attributable to the fact that the metal is covered with a thin film of $n\text{-}TiO_2$, a semiconducting oxide known to be incapable of supporting significant anodic dark current densities.

4005 Photochemistry

Refer also to citation(s) 19481, 20001, 20006

20012 (DOE/ER/13789–3) **Studies of photochemically and electrochemically driven electron transport in zeolites: Progress report, September 1987–February 1990.** Mallouk, T.E. Texas Univ., Austin, TX (USA). Dept. of Chemistry. Feb 1990. 22p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-87ER13789. Order Number DE90007659. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The basic thrust of our DOE-funded research program involves the use of microporous aluminosilicates (zeolites and clays) as organizing media for molecular electron transport chains. In these studies the aluminosilicates cause self-assembly, by virtue of size exclusion effects, ion exchange equilibria, and specific adsorption, of photosensitizers, electron donors, and electron acceptors at the solid/solution interface. Spectroscopic and electrochemical methods are used to study the kinetics of photochemically and electrochemically driven vectorial electron transfer reactions in these assemblies.

20013 (LBL–28127) **Photodissociation studies of the chlorotoluenes at 193 nm and 248 nm.** Helfand, M.S. Lawrence Berkeley Lab., CA (USA). Nov 1989. 129p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90007079. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

The photodissociation reactions of o-, m-, and p-chlorotoluene have been investigated at 193 nm and 248 nm in a crossed molecular beam-laser beam apparatus with a rotatable molecular beam source. Chapter 2 describes the studies at 193 nm. It is found that all three isomers have three primary reaction channels, each involving loss of the chlorine atom albeit with differing amounts of the excess available energy, 51 kcal/mole, in the translational degree of freedom of the products.

4006 Radiation Chemistry

Refer also to citation(s) 20457

20014 (IAEA-TECDOC–527) **New trends and developments in radiation chemistry: Proceedings of an advisory group meeting held in Bologna, Italy, 14-17 November 1988.** International Atomic Energy Agency, Vienna (Austria). Oct 1989. 240p. (CONF-8811309–: Advisory group on the assessment of new developments and trends in radiation chemistry, Bologna (Italy), 14-17 Nov 1988). Order Number DE90617335. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

Radiation chemistry is a branch of chemistry that studies chemical transformations in materials exposed to high-energy radiations. It uses radiation as the initiator of chemical reactions. Practical applications of radiation chemistry today extend to many fields, including health care, food and agriculture, manufacturing, industrial pollution abatement, biotechnology and telecommunications. The important advantage of radiation chemistry lies in its ability to be used to produce, and study, almost any reactive atomic and molecular species playing a part in chemical reactions, synthesis, industrial processes, or in biological systems. The techniques are applicable to gaseous, liquid, solid, and heterogeneous systems. By combining different techniques of radiation chemistry with analytical chemistry, the reaction mechanism and kinetics of chemical reactions are studied. In November 1988 in Bologna, Italy, the IAEA convened an advisory group meeting to assess new trends and developments in radiation chemistry. The present publication includes most of the contributions presented at the meeting. Refs, figs and tabs.

20015 (IAEA-TECDOC–527, pp. 13-21) **Pulse radiolysis, a method of choice for the fast kineticist - Past, present and future.** Sonntag, C. von (Max-Planck-Institut fuer Strahlenchemie, Muehlheim/Ruhr (Germany, F.R.)). International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8811309–: Advisory group on the assessment of new developments and trends in radiation chemistry, Bologna (Italy), 14-17 Nov 1988). In *New trends and developments in radiation chemistry: Proceedings of an advisory group meeting held in Bologna, Italy, 14-17 November 1988.* Order Number DE90617335. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

In the past, radiation chemistry has made considerable contributions to our present knowledge of free-radical chemistry. This was largely due to the pulse radiolysis technique which has been established some 25 years ago. Although it is true that one of its most notable contributions, the establishment of reliable rate constants for the reactions of the water radicals (OH, H and e_{aq}^-) with a host of organic and inorganic compounds is losing in importance because this technique has provided us with a body of many excellent data and a picture of the reactivity of various classes of compounds has now emerged, there are developments in the pulse radiolysis technique itself which will make possible another breakthrough in free-radical research. These recent developments are briefly discussed. (author). 56 refs.

20016 (IAEA-TECDOC–527, pp. 23-41) **New applications of pulse radiolysis in general chemistry.** Pikaev, A.K. (AN SSSR, Moscow (USSR). Inst. Fizicheskoj Khimii); Kabakchi, S.A.; Makarov, I.E.; Gogolev, A.V. International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8811309–: Advisory group on the assessment of new developments and trends in radiation chemistry, Bologna (Italy), 14-17 Nov 1988). In *New trends and developments in radiation chemistry: Proceedings of an advisory group meeting held in Bologna, Italy, 14-17 November 1988.* Order Number DE90617335. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

The pulse radiolysis method is widely used not only for the study of primary radiolytical processes, but also for the solution of different problems of general chemistry. The report is a short review of the new results obtained by us from the study of some applications of this method in general chemistry. The data on kinetics of fast reactions of hydrogen ions in aqueous solutions including temperature dependence of reaction rate, reactivity of inorganic free radicals (SO_4^-, NO_3, Cl_2^-, CO_3^- etc.) towards ions of transition metals including ions of lanthanides and actinides in aqueous solutions and autooscillation processes in some irradiated systems (mainly in concentrated aqueous solutions of halides of alkaline and alkaline-earth metals) are discussed. (author). 44 refs, 4 figs, 7 tabs.

20017 (IAEA-TECDOC–527, pp. 43-49) **From radiation chemistry to energetics via photoelectrochemistry - Electrons and hydrogen atoms in liquids.** Schiller, R. (Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics). International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8811309–: Advisory group on the assessment of new developments and trends in radiation chemistry, Bologna (Italy), 14-17 Nov 1988). In *New trends and developments in radiation chemistry: Proceedings of an advisory group meeting held in Bologna, Italy, 14-17 November 1988.* Order Number DE90617335. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

The interrelation between radiation chemistry and photoelectrochemistry is demonstrated by several examples. The studies of electron injection into liquids by illuminating metal cathodes render information on excess electron energies, on electron thermalization, transport and reactivity. Atomic hydrogen can be injected into the aqueous phase through the illumination of tungsten bronze cathodes immersed into acid solutions. An outlook of the relevance of these and similar processes on light energy conversion is given. (author). 12 refs, 1 fig.

20018 (IAEA-TECDOC–527, pp. 51-67) **Assessment of the radiation chemistry of water and aqueous solutions at elevated temperatures.** Buxton, G.V. (Leeds Univ. (UK). Cookridge High Energy Radiation Research Centre). International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8811309–: Advisory group on the assessment of new developments and trends in radiation chemistry, Bologna (Italy), 14-17 Nov 1988). In *New trends and developments in radiation chemistry: Proceedings of an advisory group meeting held in Bologna, Italy, 14-17 November 1988.* Order Number DE90617335. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

Recently obtained experimental data which are relevant to the chemistry of water-cooled reactors are summarised and assessed. Several reports on the yields of some of the primary radiolytic products from water are broadly in agreement that the pattern of water radiolysis does not change very markedly between room temperature and ca. 250 deg. C. The yields of radicals (e_{aq}^-, H, OH) increase smoothly by ca. 0.2% per deg. C in neutral solution, and by ca. 0.1% per deg. C in 0.4 mol dm^{-3} H_2SO_4. The pK's of OH and HO_2 show temperature dependences typical of weak acids. It is concluded that yields and pK's can be extrapolated to reactor temperatures with some confidence. Kinetic measurements reveal that some important reactions which are diffusion controlled

at ambient temperature become activation controlled at elevated temperatures. (author). 21 refs, 3 figs, 2 tabs.

20019 (IAEA-TECDOC–527, pp. 69-78) **Current status of radiation chemical studies with heavy ions.** Schuler, R.H. (Notre Dame Univ., IN (USA). Radiation Lab.); Laverne, J.A. International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8811309–: Advisory group on the assessment of new developments and trends in radiation chemistry, Bologna (Italy), 14-17 Nov 1988). In *New trends and developments in radiation chemistry: Proceedings of an advisory group meeting held in Bologna, Italy, 14-17 November 1988.* Order Number DE90617335. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

The history of radiation chemical studies with heavy ions is briefly reviewed and the scope of current activities is summarized. Attention is focused on the significance of these studies to discussions of track effects in radiation chemistry. (author). 13 refs, 1 tab.

20020 (IAEA-TECDOC–527, pp. 79-88) **Solid state pulse radiolysis.** Zagorski, Z.P. (Institute of Nuclear Chemistry and Technology, Warsaw (Poland)). International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8811309–: Advisory group on the assessment of new developments and trends in radiation chemistry, Bologna (Italy), 14-17 Nov 1988). In *New trends and developments in radiation chemistry: Proceedings of an advisory group meeting held in Bologna, Italy, 14-17 November 1988.* Order Number DE90617335. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

The paper stresses the insufficient knowledge of solid state radiation chemistry contrasting with well developed radiation chemistry of liquids. The basic difference between solids and liquids consists in rapid decay of intermediates in the latter and a long life of reactive species in the solid state, due to a low mobility of system constituents. Due to esr investigation, radiothermoluminescence, lyoluminescence, etc., the knowledge is developing on comparatively stable species, but their precursors, or other short lived species decaying to stable compounds remain unknown. In spite of experimental difficulties, caused mainly by a not sufficient transparency of samples, pulse radiolysis in the solid state is developing. Different approaches are presented with examples of results. They contribute to the knowledge of solid state radiation chemistry. Nonoptical methods of detection of intermediates in solid state pulse radiolysis (e.g. electrical conductivity) are not discussed in the present paper. (author). 8 refs, 1 fig.

20021 (IAEA-TECDOC–527, pp. 89-96) **Immobilization of asparaginase in radiation cured, thermally reversible hydrogels.** Mechain, B. (Washington Univ., Seattle, WA (USA). Center for Bioengineering); Sun, Y.; Hoffman, A. International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8811309–: Advisory group on the assessment of new developments and trends in radiation chemistry, Bologna (Italy), 14-17 Nov 1988). In *New trends and developments in radiation chemistry: Proceedings of an advisory group meeting held in Bologna, Italy, 14-17 November 1988.* Order Number DE90617335. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

We have immobilized asparaginase in a thermally reversible hydrogel by radiation curing solutions of N-isopropyl acrylamide mixed with monomer-conjugated enzyme and a crosslinker. We then measured the immobilized enzyme activities as a function of radiation dose and temperature. The immobilized enzyme is much more stable to radiation than the free enzyme or the monomer-conjugated enzyme. We have found that we are able to cycle the gel above and below its lower critical solution temperature, causing a reversible shrinking and swelling of the gel to occur in the aqueous environment, without significant loss of enzyme activity. The enzyme activity is "turned off" in the shrunken gel above the LCST, but regains its activity when the gel reswells below the LCST. This system represents a novel way of preparing an immobilized enzyme reactor which can be turned on and off by small changes in temperature, and which then may act as a temperature sensitive reaction "valve" for exothermic reactions. (author). 24 refs, 4 figs.

20022 (IAEA-TECDOC–527, pp. 97-104) **Some aspects of radiation chemistry of epoxies.** Singh, A. (Atomic Energy of Canada Ltd., Pinawa, MB (Canada). Whiteshell Nuclear Research Establishment); Saunders, C.B.; Carmichael, A.A.; Lopata, V.J. International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8811309–: Advisory group on the assessment of new developments and trends in radiation chemistry, Bologna (Italy), 14-17 Nov 1988). In *New trends and developments in radiation chemistry: Proceedings of an advisory group meeting held in Bologna, Italy, 14-17 November 1988.* Order Number DE90617335. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

Epoxides can be radiation-polymerized using electron beam or gamma irradiation. The polymerization process occurs mostly by a cationic mechanism. Water acts as an inhibitor of the cationic mechanism, and, therefore, monomers have to be carefully dried. Epoxies are used in a large variety of products, including structural composites. Radiation polymerization of their matrices offers some unique advantages, such as lower residual stresses due to ambient temperature processing. Carbon fibre-epoxy composites are used extensively in satellites. Because of the concerns about the integrity of satellite components in outer space, there is also considerable interest in the study of radiation effects on epoxies. Polymer matrices in the composites used in satellites in geosynchronous orbits get exposed to very high doses during their lifespan of approx30 years. In this paper, radiation polymerization of cyclohexene oxide, as an example of the radiation polymerization of epoxides, radiation curing of carbon fibre-acrylated epoxy composites and radiation effects on some epoxies are briefly reviewed. (author). 24 refs, 1 tab.

20023 (IAEA-TECDOC–527, pp. 105-116) **The radiation chemistry of connective tissue; hyaluronic acid.** Myint, P. (North East Wales Inst. of Higher Education, Connah's Quay (UK). Kelsterton Coll.); Deeble, D.J.; Phillips, G.O. International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8811309–: Advisory group on the assessment of new developments and trends in radiation chemistry, Bologna (Italy), 14-17 Nov 1988). In *New trends and developments in radiation chemistry: Proceedings of an advisory group meeting held in Bologna, Italy, 14-17 November 1988.* Order Number DE90617335. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

Aqueous solutions of hyaluronic acid have been irradiated under various conditions and the amount of strand scission was determined viscometrically. OH radicals were found to be some 1.5 times more potent than H atoms at inducing breaks, methanol, propan-2-ol and t-butanol radicals produced relatively little breakage (potency less than 3% that of ·OH). Tetranitromethane (TNM) has been used to measure the yield of reducing radicals produced on OH radical attack on hyaluronic acid, around 80% of the hyaluronic acid radicals reacted with TNM (i.e. are reducing radicals) with a rate constant of 4.5×10^8 mol^{-1} dm^3 s^{-1}. In contrast similar measurements on the polysaccharide model, beta-cyclodextrin, indicated that all the radicals formed were reducing. The presence of TNM or oxygen during radiolysis caused a 30% fall in chain breakage. The majority of radicals produced in both hyaluronic acid and beta-cyclodextrin are either 1,2 dihydroxy or 1-hydroxy 2-alkoxy type radicals, both of which form beta-carbonyl radicals by the acid (and base) catalysed elimination of water or alcohol. These beta-carbonyl radicals are considerably less reducing than their parent alpha-hydroxy radicals and are not expected to react with TNM. By determining the extent of reaction with TNM as a function of TNM concentration, the first order rate constant for the formation of the beta-carbonyl radicals can be calculated on applying simple competition kinetics. The rate constant at pH 4 was found to be about 4×10^3 s^{-1} in the case of hyaluronic acid radicals, with the beta-cyclodextrin system even at pH 2.8 the rate constant was less than 2×10^3 s^{-1}. (author). 12 refs, 1 fig., 1 tab.

20024 (IAEA-TECDOC–527, pp. 117-126) **The use of polymers for solar photochemistry. Application of ionizing radiation methods for the binding of functional groups to polymers.** Rabani, J. (Hebrew Univ., Jerusalem (Israel). Dept. of Physical Chemistry). International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8811309–: Advisory group on the assessment of new developments and trends in radiation chemistry, Bologna (Italy), 14-17 Nov 1988). In *New trends and developments in radiation chemistry: Proceedings of an advisory group meeting held in Bologna, Italy, 14-17 November 1988.* Order Number

DE90617335. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

The application of polymers for photochemical energy storage is described. A system is reported which enables the storage of energy for a time period in the range of minutes. Such systems require polymers covalently linked to specific functional groups, which is the only way to achieve linkage between a polymeric ion and a specific group which possess the same electric charge. In systems where the binding is a result of electrostatic interactions only, a local opposite field exists at the site of the reaction. In such cases, the retardation is by 2-3 orders of magnitude as compared with 6-7 orders which is observed in covalently linked systems. A method based on application of ionizing radiation for the formation of covalent links between a polymer, and a functional molecule is reported. It requires pulse radiolytic investigations of the chemical kinetics in polymer solutions as well as in the solutions of the functional molecules. The advantage of the radiation induced method is that it enables the use of natural polymers. It can be applied to fields other than photochemical storage of energy, such as preparation of model systems for biological and medical research, on line analysis and specific interactions. (author). 18 refs, 5 figs.

20025 (IAEA-TECDOC–527, pp. 129-139) **Recent developments in radiation chemistry at IRI-TU Delft.** Hummel, A. (Technical Univ. Delft (Netherlands). Interfaculty Reactor Inst.). International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8811309–: Advisory group on the assessment of new developments and trends in radiation chemistry, Bologna (Italy), 14-17 Nov 1988). In *New trends and developments in radiation chemistry: Proceedings of an advisory group meeting held in Bologna, Italy, 14-17 November 1988.* Order Number DE90617335. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

The research in the radiation chemistry group at IRI-TU Delft comprises the following activities: (a) Fundamental radiation chemistry; Charge separation in nonpolar liquids; Ionization and recombination non-homogeneous kinetics; Computer simulation of spurs; Thermalization; Primary species; Holes, electrons and excited states. (b) Applications to research in various fields; Polymers; Catalysis; Biological systems; DNA; Solar energy. (c) Development of experimental facilities; Pulsed Van de Graaff accelerator; Optical detection, absorption and emission; Conductivity, DC and microwaves; Product analysis; Data treatment and automatization. The development in the various research projects will be discussed. (author). 31 refs.

20026 (IAEA-TECDOC–527, pp. 141-146) **New developments in radiation chemistry applications in Japan.** Machi, S. (Japan Atomic Energy Research Inst., Takasaki, Gunma (Japan). Takasaki Radiation Chemistry Research Establishment). International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8811309–: Advisory group on the assessment of new developments and trends in radiation chemistry, Bologna (Italy), 14-17 Nov 1988). In *New trends and developments in radiation chemistry: Proceedings of an advisory group meeting held in Bologna, Italy, 14-17 November 1988.* Order Number DE90617335. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

Industrial application of radiation chemistry was first achieved in 1960 and has grown since then in mainly polymeric materials and medical products sterilization. Nowadays about 180 electron beam machines are used for radiation processing. Research and development have been carried out in governmental institutes such as JAERI and private companies, and new applications have been commercialized. Environmental conservation is an important task in Japan and an application study of radiation processing for this purpose has also been conducted. Radiation chemistry is also playing an important role to estimate the life-time of organic materials used in nuclear plants under radiation exposure. This paper reports an overview of up-to-date radiation applications and its future trends in Japan. (author). 3 figs, 2 tabs.

20027 (IAEA-TECDOC–527, pp. 147-156) **General survey of radiation chemistry in France.** Gilles, L. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Technologique et de Developpement Industriel (IRDI)). International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8811309–: Advisory group on the assessment of new developments and trends in radiation chemistry, Bologna (Italy), 14-17 Nov 1988). In *New trends and developments in radiation chemistry: Proceedings of an advisory group meeting held in Bologna, Italy, 14-17 November 1988.* Order Number DE90617335. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

A recent symposium held in France allowed the meeting of about a hundred French speaking scientists, fundamental and applied researchers as well as industrialists, interested in the field of radiation chemistry. Five principal topics will be considered: 1. Studies on the primary effects of the interaction of radiation with matter for which a strong correlation appears between radiolytic and photolytic studies to understand the solvation process of electrons; 2. Studies of chemical reactions induced by radiolysis for which the use of heavy ions can give a new impulse; 3. Studies on the effects of radicals in biochemistry for which the radiolytic methods appear the best way to produce radicals involved in biological mechanism as, for instance, respiration; 4. Studies on the biological effects of radiation and more particularly some effects of hydroxyl radical; 5. Some industrial applications of radiation for grafting and reticulation of polymers with a view to destroying pathogenic germs in food. The fate of water and solutes used in nuclear reactors as well as the effects of irradiation on nuclear wastes will also be considered. New questions in radiation chemistry will suggest studies in which radiolytic methods are essential. 1 tab.

20028 (IAEA-TECDOC–527, pp. 157-164) **Concepts of radiation research in the German Democratic Republic.** Leonhardt, J.W. (Akademie der Wissenschaften der DDR, Berlin (German Democratic Republic). Forschungsbereich Physik). International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8811309–: Advisory group on the assessment of new developments and trends in radiation chemistry, Bologna (Italy), 14-17 Nov 1988). In *New trends and developments in radiation chemistry: Proceedings of an advisory group meeting held in Bologna, Italy, 14-17 November 1988.* Order Number DE90617335. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

Current status and current projects of radiation application in GDR are described. Basic research is discussed. (author). 16 refs.

20029 (IAEA-TECDOC–527, pp. 165-170) **Radiation chemistry at Harwell.** Burns, W.G. (UKAEA Harwell Lab. (UK)). International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8811309–: Advisory group on the assessment of new developments and trends in radiation chemistry, Bologna (Italy), 14-17 Nov 1988). In *New trends and developments in radiation chemistry: Proceedings of an advisory group meeting held in Bologna, Italy, 14-17 November 1988.* Order Number DE90617335. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

Radiation chemistry is pursued at Harwell in order to provide a basis for advice given to the nuclear industry where the efficiency and safety of its operations, with respect both to its own workers and the general public, could potentially be affected by radiation chemical effects. For example we advise the fuel reprocessing organization, (BNF plc) the nuclear reactor construction (NNC) and operating organizations (CEGB), and undertake relevant contract work for external customers. We undertake specific investigations involving experiments and their interpretation, including predictions involving scaling from laboratory experiments to large scale systems, and purely modelling projects. The types of system investigated are varied. In gas phase radiolysis they include high dose rate fission fragment irradiation of caesium iodide vapour in helium at ca 400 deg. C in the fuel clad gap, where iodine atom concentrations can affect stress corrosion cracking of the Zircaloy cladding. Another gas phase investigation addresses the gamma/neutron irradiation of $CO_2/CH_4/H_2O$ mixtures in advanced gas-cooled reactors, where carbonaceous deposits on surfaces can affect reactor efficiency. We work on systems related to the storage and transport of irradiated aqueous or wet materials, including the radiolysis of plutonium nitrate solutions. Important topics are the effect of irradiation on corrosion, and the speciation of the actinides in long-term repository storage. This speciation is normally calculated using thermodynamic principles which do not apply in a radiation field and we evaluate the impact of radiolytic reactions by establishing the rates of the forward and reverse reactions which

control the notional redox equilibria and potentials so that reactions of radiolytic species can be allowed to compete with them. (Abstract Truncated)

20030 (IAEA-TECDOC–527, pp. 171-183) **An overview of some basic and applied radiation chemistry studies at Trombay.** Moorthy, P.N. (Bhabha Atomic Research Centre, Bombay (India). Chemistry Div.). International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8811309–: Advisory group on the assessment of new developments and trends in radiation chemistry, Bologna (Italy), 14-17 Nov 1988). In *New trends and developments in radiation chemistry: Proceedings of an advisory group meeting held in Bologna, Italy, 14-17 November 1988.* Order Number DE90617335. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

Radiation Chemistry and related aspects constitute the basis of R and D programmes in many groups at the Bhabha Atomic Research Centre (BARC) at Trombay. The present paper gives an overview of the recent researches carried out in this field in the Chemistry Division of BARC. These comprise: (i) studies on the generation and reactions of transient species by the pulse radiolysis technique, (ii) charge migration and reaction in glassy matrices, (iii) radiation induced polymerization, (iv) radiation protection of vitamins, (v) radiation effects on lubricants, (vi) biomedical applications of radiation cross linked PVA gel and (vii) effect of high energy alpha-particles on the catalytic properties of oxides. Some of the topics proposed to be investigated in the near future are also mentioned. (author). 32 refs, 1 fig.

20031 (IAEA-TECDOC–527, pp. 185-191) **Radiation chemistry in China.** Wu Jilan (Beijing Univ., BJ (China). Dept. of Technical Physics); Wang Guanghui. International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8811309–: Advisory group on the assessment of new developments and trends in radiation chemistry, Bologna (Italy), 14-17 Nov 1988). In *New trends and developments in radiation chemistry: Proceedings of an advisory group meeting held in Bologna, Italy, 14-17 November 1988.* Order Number DE90617335. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

Radiation chemistry in China has a short but remarkable history. It has evolved, first, from the interest for chemistry related to the technology of nuclear reactors and radiation effects on polymers or induced polymerization. Several universities in China introduced radiation chemistry into academic curriculum, undergraduate and graduate level, in early 1960s. At present there are 10-15 centres in China actively involved in fundamental and applied research in radiation chemistry, at universities, national and local institutions. The research programmes, cover a broad range of topics from primary processes in radiation chemistry to various applications in industry, biology and medicine. As of 1983 the Journal of Radiation Research and Radiation Processing is regularly published. (author). 4 refs.

20032 (IAEA-TECDOC–527, pp. 195-197) **Intramolecular long range electron transfer reactions in peptides and proteins.** Faraggi, M. (Israel Atomic Energy Commission, Beersheba (Israel). Nuclear Research Center-Negev); Klapper, M.H. International Atomic Energy Agency, Vienna (Austria). Oct 1989. Grant 85-00217;Grant 86-00206;Grant GM-35718. (CONF-8811309–: Advisory group on the assessment of new developments and trends in radiation chemistry, Bologna (Italy), 14-17 Nov 1988). In *New trends and developments in radiation chemistry: Proceedings of an advisory group meeting held in Bologna, Italy, 14-17 November 1988.* Order Number DE90617335. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

Published in summary form only. PEPTIDES/electron transfer; PROTEINS/electron transfer; INTERACTION RANGE; MOLECULAR STRUCTURE; PEPTIDES; PHOTOLYSIS; PROTEINS; PULSED IRRADIATION; RADIOLYSIS

20033 (IAEA-TECDOC–527, pp. 203-205) **Some implications of studies of electrons in fluids for the visualization of quantum mechanics.** Freeman, G.R. (Alberta Univ., Edmonton, AB (Canada). Dept. of Chemistry). International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8811309–: Advisory group on the assessment of new developments and trends in radiation chemistry, Bologna (Italy), 14-17 Nov 1988). In *New trends and developments in radiation chemistry: Proceedings of an advisory group meeting held in Bologna, Italy, 14-17 November 1988.* Order Number DE90617335. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

Published in summary form only. 2 refs., 1 fig. CALCIUM/chemical radiation effects; CALCIUM; COUPLING; DISSOCIATION; ELECTRON MOBILITY; ELECTRON-MOLECULE COLLISIONS; FLUORESCENCE; G VALUE; IRRADIATION; LIQUIDS; VISIBLE SPECTRA

20034 (IAEA-TECDOC–527, pp. 207-209) **Advancements of radiation induced degradation of pollutants in drinking and waste water.** Getoff, N. (Vienna, Univ. (Austria). Inst. fuer Theoretische Chemie und Strahlenchemie). International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8811309–: Advisory group on the assessment of new developments and trends in radiation chemistry, Bologna (Italy), 14-17 Nov 1988). In *New trends and developments in radiation chemistry: Proceedings of an advisory group meeting held in Bologna, Italy, 14-17 November 1988.* Order Number DE90617335. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

Published in summary form only. 1 ref., 2 figs., 1 tab. DRINKING WATER/irradiation; POLLUTANTS/radiolysis; WASTE WATER/irradiation; DECOMPOSITION; IRRADIATION; ORGANIC CHLORINE COMPOUNDS; POLLUTANTS; RADIOLYSIS; WATER TREATMENT

20035 (IAEA-TECDOC–527, pp. 211) **The radiolysis of aqueous solutions of glycosides.** Yuan Rongyao (Beijing Univ., BJ (China). Dept. of Technical Physics); Wu Jilan. International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8811309–: Advisory group on the assessment of new developments and trends in radiation chemistry, Bologna (Italy), 14-17 Nov 1988). In *New trends and developments in radiation chemistry: Proceedings of an advisory group meeting held in Bologna, Italy, 14-17 November 1988.* Order Number DE90617335. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

Published in summary form only. GLYCOSIDES/radiolysis; RADIOSTERILIZATION/safety standards; AQUEOUS SOLUTIONS; G VALUE; GLYCOSIDES; RADIOLYSIS; RADIOSTERILIZATION; SCAVENGING

20036 (IAEA-TECDOC–527, pp. 213) **Using multi-effects of chemical scavengers to study the radiolysis of cyclohexane-4-methyl-4-phenyl-2-pentanone system and cyclohexane-tributyl-phosphate system.** Zhang Nan (Beijing Univ., BJ (China). Dept. of Technical Physics); Wu Jilan. International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8811309–: Advisory group on the assessment of new developments and trends in radiation chemistry, Bologna (Italy), 14-17 Nov 1988). In *New trends and developments in radiation chemistry: Proceedings of an advisory group meeting held in Bologna, Italy, 14-17 November 1988.* Order Number DE90617335. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

Published in summary form only. CYCLOHEXANE/radiolysis; SCAVENGING/chemical reaction kinetics; CHEMICAL REACTION YIELD; CYCLOHEXANE; RADIOLYSIS; KETONES; SCAVENGING; TBP

20037 (IAEA-TECDOC–527, pp. 215-216) **The crystallization kinetics of irradiated polypropylene with additives.** Chen Wenxiu (Beijing Univ., BJ (China). Dept. of Technical Physics); Yu Shui. International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8811309–: Advisory group on the assessment of new developments and trends in radiation chemistry, Bologna (Italy), 14-17 Nov 1988). In *New trends and developments in radiation chemistry: Proceedings of an advisory group meeting held in Bologna, Italy, 14-17 November 1988.* Order Number DE90617335. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

Published in summary form only. 2 figs. POLYPROPYLENE/chemical radiation effects; POLYPROPYLENE/crystallization; ADDITIVES; CHEMICAL REACTION KINETICS; IRRADIATION; POLYPROPYLENE; CRYSTALLIZATION

20038 (IAEA-TECDOC–527, pp. 219-237) **Radiation chemistry of flue gases.** Busi, F. (Bologna Univ. (Italy). Ist. di Scienze Chimiche). International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8811309–: Advisory group on the assessment of new developments and trends in radiation chemistry, Bologna (Italy), 14-17 Nov 1988). In *New trends and developments in radiation chemistry: Proceedings of an advisory group meeting held in Bologna, Italy, 14-17 November 1988.* Order Number DE90617335. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

A chemical mechanism for the radiolysis of combustion gases produced in fossil fuel power plants, in agreement with a large body of experimental results is presented. The process represent an example of successful application of radiation chemistry to the control of air pollution problems. (author). 27 refs, 8 figs.

20039 Reduction Potentials of One-Electron Couples Involving Free Radicals in Aqueous Solution. Wardman, P. (Gray Laboratory of the Cancer Research Campaign, Mount Vernon Hospital, Northwood Middlesex HA6 2JR, United Kingdom (GB)). *Journal of Physical and Chemical Reference Data (USA),* 18(4): 1637-1755 (Oct 1989).

Reduction of an electron acceptor (oxidant), A, or oxidation of an electron donor (reductant), A^{2-}, is often achieved stepwise *via* one-electron processes involving the couples $A/A\cdot^-$ or $A\cdot^-/A^{2-}$ (or corresponding prototropic conjugates such as A/AH· or AH·/AH_2). The intermediate $A\cdot^-$(AH·) is a free radical. The reduction potentials of such one-electron couples are of value in predicting the direction or feasibility, and in some instances the rate constants, of many free-radical reactions. Electrochemical methods have limited applicability in measuring these properties of frequently unstable species, but fast, kinetic spectrophotometry (especially pulse radiolysis) has widespread application in this area. Tables of *ca.* 1200 values of reduction potentials of *ca.* 700 one-electron couples in aqueous solution are presented. The majority of organic oxidants listed are quinones, nitroaryl and bipyridinium compounds. Reductants include phenols, aromatic amines, indoles and pyrimidines, thiols and phenothiazines. Inorganic couples largely involve compounds of oxygen, sulfur, nitrogen and the halogens. Proteins, enzymes and metals and their complexes are excluded.

20040 Radiolytic studies of the redox reactions of ruthenium porphyrins. *Journal of Physical Chemistry (USA),* 93(6): 2358-2362 (23 Mar 1989).

Oxidation of Ru^{II} porphyrins to the Ru^{III} and Ru^{IV} states and ligand-exchange reactions of the various states have been studied by radiolytic methods. Ru^{II} porphyrins, stabilized with a CO ligand, undergo one-electron oxidation on the porphyrin ring to form the π-radical cation. When $Ru^{II}(P)(CO)$ (P = octaethylporphyrin or tetraphenylporphyrin) is oxidized by irradiation in CH_2Cl_2, the initial radical cation combines with Cl^-, formed by radiolysis of the solvent or added beforehand, with a rate constant of about 1×10^5 M^{-1} s^{-1} to yield $Ru^{II}(P^{\bullet+})(CO)(Cl^-)$. Irradiation of the same porphyrins in acetonitrile results not in oxidation but rather in uptake of the CN^- produced by the radiolysis to form $Ru^{II}P(C)(CN^-)$. When this product is oxidized by irradiation in acetonitrile/CCl_4 solutions, oxidation occurs first on the ligand to form $Ru^{II}(P^{\bullet+})(CO)(CN)$, which is unstable and transforms into $Ru^{III}P(CN^-)_2$ as the final product, with a rate constant of 4.5×10^3 s^{-1}. The Ru^{IV} state exists mainly as the μ-oxo dimer, which was produced by radiolysis of $Ru^{II}(CO)$ in CH_2Cl_2 saturated with KOH. The product, $[(HO)Ru^{IV}P]_2O$, undergoes a gradual exchange of the OH groups with one and then two chlorides upon radiolysis in CH_2Cl_2 as was demonstrated by the spectral changes. Chemical redox reactions were carried out to complement the radiolysis results.

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Refer also to citation(s) 20431

20041 (IAEA-TECDOC–532) **Development of new radiopharmaceuticals: Final report of a research co-ordination meeting held in Athens, 12-15 September 1988.** International Atomic Energy Agency, Vienna (Austria). Dec 1989. 70p. (CONF-8809448–: Research co-ordination meeting on development of new radiopharmaceuticals, Athens (Greece), 12-15 Sep 1988). Order Number DE90617325. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

The possibilities to design and prepare better and more organ-specific radiopharmaceuticals for diagnostic nuclear medicine has increased dramatically in the recent past with a deeper understanding of the relationships between chemical structure and biological activity. Whereas most of the research is performed in well-funded laboratories of industrialized countries, there are several developing countries with adequate resources and expertise as to undertake fruitful research in the field of radiopharmacy. With the aim of promoting advanced research in radiopharmacy by developing new radiodiagnostics agents, in particular, hepatobiliary imaging agents labelled with ^{99m}Tc, and to facilitate exchange of information, the IAEA has established in 1983 the present Research Co-ordination Programme (CRP) with a duration of five years. The report includes detailed results obtained by all participants as well as novel preparation procedures for some of the newest and more promising radiopharmaceuticals developed under the auspices of the CRP. The extensive bibliographic reference listing is considered another important information of particular value for scientists in developing countries who do not always have access to updated scientific information sources. Refs, figs and tabs.

20042 (IPEN-PUB–264) **Radiation induced color in topaz crystals.** Castagnet, A.C.; Rocca, H.C.C.; Rostilato, M.E.C.M. Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo, SP (Brazil). Aug 1989. 26p. (In Portuguese). Order Number DE90617328. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The presence of defects and impurities in the crystal lattice alters the eletric field distribution within the crystal, allowing the electrons to occupy energy levels in the forbbiden band. Ionizing radiation supply the required energy to permit the electrons originaly bound to lattice atoms, to occupy effectively those intermediate levels, forming color centers. Dependig upon the nature and energy of the radiation, it is possible to produce defects in regions of the crystal, generating color centers. Based on these premises, a technique to induce color in originally colorless topaz, by using the IEA-R1 nuclear reactor, was developed at Engineering and Industrial Application Department (TE). Samples were irradiated inside iron capsules coated with cadmium foils. The iron, and principaly the cadmium, absorb the thermal neutrons that could activate crystal impurities generating long-lived radioisotopes. The epithermal neutrons that overpass the iron and cadmium barriers interact with the crystal atoms, causing lattice defects which give rise to color center, by subsequent ionization processes. The procedure used at TE induces permanent blue color, in natural colorless topaz. (author).

20043 (IPEN-PUB–277) **Studies of labelling conditions for gentamicin with^{99m}Tc Biological uptake.** Carvalho, O.G. de; Almeida, M.A.T.M. de; Muramoto, E. Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo, SP (Brazil). Oct 1989. 11p. (In Portuguese). Order Number DE90617329. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Gentamicin sulphate is an aminoglycoside antibiotic type specifically used for treatment of infections produced by Gram-negative bacterias but on the hand it presents ototoxic reactions as a serious side effect. The optimal labelling conditions of gentamicin sulphate with^{99m}Tc, using sodium pertechnetate solutions eluted from a ^{99}Mo -^{99m}Tc generator, were stablished by testing differents masses of antibiotic and reducing agent ($SnCl^2.2H_2O$), and also different reaction times and final labelling pH. The labelling yields were determined through ascendent type crimatographic analysis using metylacetone and 0,9% NaCl solution as solvents. From the studies of the biological uptake of^{99m}Tc gentamicin sulphate per gram of eight different organs and tissues from Wistar rats, it was shown that for a dose of 0,3 mg of^{99m}Tc-gentamicin intravenously administered. The kidneys, presented the greatest affinity for the drug, being thus the main excretory organs of the product. (author).

20044 (ISH–131) **Chemical, radiochemical and radionuclidic purity of various Mo-99/Tc-99m generators. Quality control.** Reich, E.; Boegl, K.W. Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene; Bundesministerium fuer Umwelt, Naturschutz und Reaktorsicherheit, Bonn (Germany, F.R.). Feb 1989. 149p. (In German). Available

from Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene. Available from Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene.

The quality control was carried through at seven different generators sold on the market of the Federal Republic of Germany, which were all loaded with fission molybdenum. The Mo-99 content of the aluminium oxide column was measured. Determination of the elution efficiency, measurement of the pH-value of the eluate as well as a test to detect soluble aluminium in the eluate were also performed. Application, quality of accessories and their practicability was tested at all generators. The methods of analysis chosen were, among others, gamma spectrometry and thinlayer chromatography; the measuring methods were a site-sensitive proportional counter (measurement of the distribution of radioactivity on the chromatograms) and the atomic absorption spectrometry. The quality control of the Tc-99 m eluates had satisfying results. The eluates showed - with one exception - high and sufficient radionuclidic purity and very good radiochemical purity. A considerable overload of the column with Mo-99 at the period of reference was not found. The elution yields with values of 85% and 122% were in good agreement with the requirements. All eluates had pH-values between 5.0 and 6.5, and an aluminium content below 1 μg/ml. The generators had good performance and proved generally to be a reliable source for the generation of Tc-99 m pertechnetate. The application was safe and, with some exceptions, fulfilled the requirements. (orig./HP).

20045 (KFK–4623) **Correlations between molecular structure and charge distribution in organometallic complexes of lanthanoids and actinoids.** Maier, R. Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Heisse Chemie. Oct 1989. 348p. (In German). Order Number DE90753307. Available from NTIS (US Sales Only), PC A15/MF A01.

The correlation between molecular structure and charge distribution was investigated in organometallic compounds of the lanthanoid (4f-) and actinoid (5f-) elements. These compounds are suitable models for two reasons: (a) they are soluble in nonpolar solvents and (b) in both series, there is a possibility for continuous variation of the ionic size of the central ion. Detailed investigation of several compound-classes with different molecular symmetry, has given important information concerning the influence of the molecular structure on the macroscopic charge distribution in the molecule. The anisotropy of the charge distribution in the molecule increases with decreasing of the molecular symmetry. Contrary to predictions previously discussed in the literature, it has been shown, that the molecular symmetry primarily does not depend on sterical interactions, but on the Coulomb-interaction between the central ion and the ligand. Using different models which take into account the molecular geometry and the charge distribution, it was possible to calculate the partial electrical moments between ligand and central ion for several coordinating atoms of the used ligands. The contribution of the f-electrons to the total charge distribution around the central ion can be quantitatively calculated from the molecular polarizability and the total charge distribution of the investigated molecule. (orig./RB).

20046 **The solubility of plutonium hydroxide in dilute solution and in high-ionic-strength chloride brines.** Felmy, A.R. (Battelle Pacific Northwest Labs., Richland, WA (USA)); Rai, D.; Schramke, J.A.; Ryan, J.L. *Radiochimica Acta (Germany, F.R.)*, 48(1/2): 29-35 (1989).

The solubility of $Pu(OH)_3$ is determined in deionized water and in chloride brines that contained Fe powder to maintain Pu in the Pu(III) oxidation state. The presence of aqueous Pu(III) was verified experimentally. The solubility of $Pu(OH)_3$ is several orders of magnitude greater in brines than in deionized water at the same hydrogen ion concentration. The logarithm of the equilibrium constant, extrapolated to zero ionic strength from experiments in deionized water, for the reaction $Pu(OH)_3 \rightleftarrows Pu^{3+} + 3\ OH^-$ is determined to be -26.2±0.8. The data for solubility in brines are interpreted in terms of the ion-interaction model of Pitzer and coworkers for the excess solution free energy. These solubility data can be explained to within experimental error by a relatively simple ion-interaction model that includes only binary interactions between Pu^{3+} and Cl^-. Ion pairs or ternary interaction parameters for Pu^{3+} were not required in order to predict the solubility of $Pu(OH)_3$ in natural chloride-dominated brines at -log[H^+] values of <9, where brackets represent concentration. (orig.).

20047 **Synthesis and coordination properties of (sulfinylmethyl)phosphonates and (sulfonylmethyl)phosphonates. Crystal and molecular structure determinations for $UO_2(NO_3)_2$ [$(i\text{-}C_3H_7O)$]$_2$ $P(I)CH_2S(O)_2$ C_6H_{112} and $Gd(NO_3)_3$ [$(i\text{-}C_3H_7O)_2$ $P(O)CH_2S(O)$ $(p\text{-}CH_3C_6H_4)$]**Karthikeyan, S. (Univ. of New Mexico, Albuquerque (USA)); Paine, R.T.; Ryan, R.R. *Inorganic Chemistry (USA)*, 28(14): 2783-2789 (12 Jul 1989).

The bifunctional (sulfonylmethyl)phosphonates $(i\text{-}C_3H_7O)_2P(O)CH_2S(I)_2C_6H_{11}$, $(i\text{-}C_3H_7O)_2P(O)CH_2S(O)_2(p\text{-}CH_3C_6H_4)$, and $(C_6H_5)_2P(O)CH_2S(O)_2N(CH_3)_2$ and (sulfinylmethyl)phosphonate $(i\text{-}C_3H_7O)_2P(O)CH_2S(O)(p\text{-}CH_3C_6H_4)$ have been synthesized. The ligands have been characterized by spectroscopic methods, and selected coordination chemistry with $UO_2(NO_3)_2$, $La(NO_3)_3$, and $Gd(NO_3)_3$ has been evaluated. The structures of two complexes, $UO_2(NO_3)_2[(i\text{-}C_3H_7O)_2P(O)CH_2S(O)_2C_6H_{11}]_2$ (2) and $Gd(NO_3)_3[(i\text{-}C_3H_7O)_2P(O)CH_2S(O)(p\text{-}CH_3C_6H_4)]\cdot H_2O$ (8), have been determined by single-crystal x-ray diffraction techniques at 23°C, and the crystal parameters are reported. The molecular structures of the two complexes are also reported. 25 refs., 2 figs., 4 tabs.

20048 **Oxidation of trivalent plutonium in acid solution by xenon difluoride and by the fluoroxysulfate ion, SO_4F^{-1}.** Cook, R.L. (Argonne National Lab., IL (USA)); Sullivan, J.C.; Appelman, E.H.; Woods, M. *Inorganic Chemistry (USA)*, 28(17): 3349-3351 (23 Aug 1989).

Stopped-flow spectrophotometry was used to study the oxidation of plutonium(III) to plutonium(IV) in 1 M $HClO_4$ by XeF_2 and by the fluoroxysulfate ion, SO_4F^-. In both reactions, 2 mol of Pu(III) is oxidized per 1 mol of oxidant consumed, and neither Pu(V) or Pu(VI) appears to be formed either as an intermediate or as an initial product, although an excess of XeF_2 does slowly oxidize the Pu(IV) product to Pu(VI). At 2°C the reactions have respective bimolecular rate constants of 1160 ± 70 and 120 ± 9 $M^{-1}\ s^{-1}$, expressed in terms of -d[Pu(III)]/dt. Over the temperature range 2-24°C, the activation parameters for the XeF_2 reaction are $\Delta H^{\ddagger}$ = 39.5 ± 8.6 kJ/mol and $\Delta S^{\ddagger}$ = −48.3 ± 29 J/(mol K), while those for the SO_4F^- reaction are $\Delta H^{\ddagger}$ = 30.8 ± 2.3 kJ/mol and $\Delta S^{\ddagger}$ = −98.5 ± 7.8 J/(mol K). Mechanisms are postulated that invoke a sequence of two one-electron-oxidation steps. 24 refs., 2 tabs.

4008 Combustion, Pyrolysis, and High-Temperature Chemistry

Refer also to citation(s) 19829

20049 (CONF-860804–18) **Statistical calculations of spherical turbulent flames.** Pope, S.B.; Chen, W.K. Massachusetts Inst. of Tech., Cambridge, MA (USA). [1986]. 27p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER13553. From 21. international symposium on combustion; Munich (Germany, F.R.); 3-8 Aug 1986. Order Number DE90006314. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Turbulent flame balls can be produced by the spark ignition of a fuel-air mixture in turbulent motion. Calculations of these statistically-spherical flames are reported and compared with the recent data of Hainsworth. The calculations are based on the Monte Carlo solution of a modelled equation for the joint probability density function (pdf) of the velocities and the reaction progress variable. In order to compare the statistical calculations with single experimental realizations, the joint pdf considered is conditioned on the turbulent velocity at the spark. This separates the flame ball's growth from its random convection by the turbulence. Excellent agreement is found between the calculated and measured evolution of the flame ball radius. 18 refs., 7 figs.

20050 (CONF-900403–6) **Corrosion evaluation of weldments exposed in TVA and Rocketdyne AFB [Atmospheric Fluid-Bed] Combustors.** Wang, D.Y.; Natesan, K. Argonne National Lab., IL (USA). Sep 1989. 25p. Sponsored by U.S. DOE Conservation & Renewable Energy; U.S. DOE Fossil Energy. DOE Contract W-31109-ENG-38. From Corrosion '90; Las Vegas, NV

(USA); 23-27 Apr 1990. Order Number DE90005630. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A number of experimental iron-, nickel-, and cobalt-based weldment materials were exposed in TVA 20MW and Rocketdyne Atmospheric Fluid-bed Combustors at 849°C for 1261 h and 871°C for 1000 h, respectively. The post-exposure analyses were conducted in Argonne National Laboratory. All specimens experienced different degrees of internal oxidation/sulfidation. Among eight filler materials, Marathon 25/35R and Haynes 188 showed the least corrosion attack, which was less than 0.5 mmpy. The high nickel content in the weldment turned out to be unfavorable for the corrosion resistance in AFBC environment. The differences in the coal/bed chemistry induced different corrosion behavior in materials exposed in TVA and Rocketdyne systems. Calcium sulfate deposit on the specimens showed significant effects on the internal oxidation/sulfidation of the alloys. The results of this study would supplement the material database, in particular weldment performance, and aid in materials selection for atmospheric fluidized bed combustor applications. 10 refs., 13 figs., 4 tabs.

20051 (N–90-11825) **Analysis of opposed jet hydrogen-air counter flow diffusion flame.** Ho, Y.H.; Isaac, K.M. Missouri Univ., Rolla, MO (USA). Oct 1989. 84p. (NASA-CR–182366;NAS–1.26:182366). Available from NTIS, PC A05/MF A01.

A computational simulation of the opposed-jet diffusion flame is performed to study its structure and extinction limits. The present analysis concentrates on the nitrogen-diluted hydrogen-air diffusion flame, which provides the basic information for many vehicle designs such as the aerospace plane for which hydrogen is a candidate as the fuel. The computer program uses the time-marching technique to solve the energy and species equations coupled with the momentum equation solved by the collocation method. The procedure is implemented in two stages. In the first stage, a one-step forward overal chemical reaction is chosen with the gas phase chemical reaction rate determined by comparison with experimental data. In the second stage, a complete chemical reaction mechanism is introduced with detailed thermodynamic and transport property calculations. Comparison between experimental extinction data and theoretical predictions is discussed. The effects of thermal diffusion as well as Lewis number and Prandtl number variations on the diffusion flame are also presented.

42 ENGINEERING

Refer also to citation(s) 20724

4202 Facilities, Equipment, and Techniques

Refer also to citation(s) 19325, 19332, 19350, 19390, 19395, 19396, 19397, 19398, 19399, 19400, 19401, 19402, 19403, 19404, 19691, 19717, 19777, 19778, 19789, 19790, 19905, 20235, 20466, 20814, 21098

20052 (CONF-890631–Vol.2, pp. 574-581) **What should be included in operating procedures for packages.** Witte, M.W. (Lawrence Livermore National Lab., CA (USA)). Oak Ridge National Lab., TN (USA). [1989]. From International symposium on packaging and transportation of radioactive materials; Washington, DC (USA); 11-16 Jun 1989. In *The 9th international symposium on the packaging and transportation of radioactive materials. Proceedings: Volume 2.* Order Number DE90004448. Available from NTIS, PC A99/MF A01.

There is a wide variation in the operating procedures currently used for shipping radioactive material to and from various nuclear facilities. This paper gives guidelines which are based on the broad experience that exists in the shipping industry and are consistent with subpart G of 10 CFR 71, and is based on NUREG/CR-4775 (1988). This paper is a very condensed version of the NUREG/CR; the reader should obtain the original for complete information. Two separate documents related to package operations are usually prepared for shipping packages. The first is a section of the SAR, usually Section 7.0, which provides information on package operations that is specific to the package. The second document is a detailed manual that is used by the package operators and handlers. It comprises all information included in the operating procedures in the SAR (in greater detail), plus all additional information necessary for package operations which is not package specific.

20053 (CONF-890631–Vol.2, pp. 544-551) **A cask maintenance facility feasibility study.** Rennich, M.J. (Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA)); Medley, L.G.; Attaway, C.R. Oak Ridge National Lab., TN (USA). [1989]. From International symposium on packaging and transportation of radioactive materials; Washington, DC (USA); 11-16 Jun 1989. In *The 9th international symposium on the packaging and transportation of radioactive materials. Proceedings: Volume 2.* Order Number DE90004448. Available from NTIS, PC A99/MF A01.

The Oak Ridge National Laboratory (ORNL) is supporting the USDOE Office of Civilian Radioactive Waste Management (OCRWM) in developing a transportation system for spent nuclear fuel (SNF) and defense high level waste (HLW) as a part of the Federal Waste Management System (FWMS). In early 1988, a feasibility study was undertaken to design a stand-alone, green field facility for maintaining the FWMS casks. The feasibility study provided an initial layout facility design, an estimate of the construction cost, and an acquisition schedule for a Cask Maintenance Facility (CMF). The study also helped to define the interfaces between the transportation system and the waste generators, the repository, and a Monitored Retrieveable Storage (MRS) facility. The data, design, and estimated cost resulting from the study have been organized for use in the total transportation system decision-making process. Most importantly, the feasibility study also provides a foundation for continuing design and planning efforts. The feasibility study was based on an assumed stand-alone green field configuration because of the flexibility this design approach provides. A stand-alone facility requires the inclusion with support functions as well as the primary process facilities thus yielding a comprehensive design evaluation and cost estimate. For example, items such as roads, security and waste processing which might be shared with an integrated or collocated facility have been fully costed in the feasibility study. Thus, while the details of the facility design might change, the overall concept used in the study can be applied to other facility configurations as planning for the total FWMS develops.

20054 (CONF-890631–Vol.2, pp. 906-912) **Transportation operations functions of the Federal Waste Management System.** Klimas, M.J. (Dept. of Energy, Argonne, IL (USA)); Shappert, L.B. Oak Ridge National Lab., TN (USA). [1989]. From International symposium on packaging and transportation of radioactive materials; Washington, DC (USA); 11-16 Jun 1989. In *The 9th international symposium on the packaging and transportation of radioactive materials. Proceedings: Volume 2.* Order Number DE90004448. Available from NTIS, PC A99/MF A01.

The Federal Waste Management Transportation System, developed for the US Department of Energys Office of Civilian Radioactive Waste Management (DOE/OCRWM) will interface with over 100 utility-owned reactors, a waste repository, possibly a Monitored Retrievable Storage (MRS) facility, and other support facilities; it will also (under normal operating conditions) be responsible for the shipment of over 3000 metric tons of uranium (MTU) throughout the US. This work will encompass a highly complex transportation operation, far exceeding any spent fuel shipping program implemented to date. To ensure that the system is adequately specified and all of its functions are identified, a Systems Engineering approach is being applied to develop the transportation system. This work was approved as part of the DOE/OCRWM program through the Chicago Operations Office, and the work is being carried out by the Transportation Operations Project Office (TOPO). This paper documents the functions that are necessary to operate the OCRWM transportation system. OCRWMs mission is to accept and transport spent fuel and high-level waste from waste generators to FWMS facilities. The emphasis is on transportation operations and assumes that all necessary facilities are in place and equipment designs and specifications are available to permit the system to operate properly. The information reported in this paper was developed for TOPO and is compatible with the draft revision of the Waste Management System Requirements and Description (SRD).

20055 (CONF-890631–Vol.3, pp. 1435-1442) **Development of honeycomb impact limiters.** Koploy, M. (General Atomics, San Diego, CA (USA)); Taylor, C. Oak Ridge National Lab., TN (USA). [1989]. DOE Contract AC07-88ID12698. From International symposium on packaging and transportation of radioactive materials; Washington, DC (USA); 11-16 Jun 1989. In *The 9th international symposium on the packaging and transportation of radioactive materials. Proceedings: Volume 3.* Order Number DE90004449. Available from NTIS, PC A99/MF A01.

General Atomics (GA), has a contract with DOEs Office of Civilian Radioactive Waste Management (OCRWM) to develop two legal weight truck casks to transport spent fuel. The GA-4 and GA-9 Casks transport four pressurized-water-reactor (PWR) and nine boiling-water-reactor (BWR) spent fuel assemblies, respectively. The preliminary designs for the GA-4 and GA-9 Casks include honeycomb impact limiters on the top and bottom of the cask bodies to protect them during any normal transport or hypothetical accident drop onto an unyielding surface. To evaluate the response of the cask during a drop, they need load versus deflection curves for the impact limiters at different impact angles. GA has developed an analytical method which in conjunction with engineering test results will be used to determine the impact limiter load versus deflection curves.

20056 (CONF-890631–Vol.3, pp. 1443-1450) **Analysis of the non-cylindrical GA-4 and GA-9 spent fuel casks.** Osborne, D. (General Atomics, San Diego, CA (USA)); Koploy, M.; Pickering, L. Oak Ridge National Lab., TN (USA). [1989]. DOE Contract AC07-88ID12698. From International symposium on packaging and transportation of radioactive materials; Washington, DC (USA); 11-16 Jun 1989. In *The 9th international symposium on the packaging and transportation of radioactive materials. Proceedings: Volume 3.* Order Number DE90004449. Available from NTIS, PC A99/MF A01.

The Nuclear Waste Policy Act (NWPA) of 1982 mandates that the US Department of Energy (DOE) establish an integrated waste management system for permanent disposal of spent nuclear fuel, commercial and defense high-level wastes, and any other waste form declared by the US Nuclear Regulatory Commission (NRC) to require permanent isolation. The mission goals of DOEs Office of Civilian Radioactive Waste Management (CRWM) require that the system be designed for maximum capacity at minimum cost within existing regulations. To support this objective, OCRWM has awarded General Atomics (GA) a contract to develop the GA-4 and GA-9 legal weight truck (LWT) transportation systems to transport pressurized-water-reactor (PWR) and boiling-water-reactor (BWR) spent fuels.

20057 (CONF-890631–Vol.3, pp. 1491-1498) **A method for evaluating structural transducers used in type B package testing.** Madsen, M.M. (Sandia National Labs., Albuquerque, NM (USA)); Uncapher, W.L.; Bronowski, D.R.; Stenberg, D.R. Oak Ridge National Lab., TN (USA). [1989]. DOE Contract AC04-76DP00789. From International symposium on packaging and transportation of radioactive materials; Washington, DC (USA); 11-16 Jun 1989. In *The 9th international symposium on the packaging and transportation of radioactive materials. Proceedings: Volume 3.* Order Number DE90004449. Available from NTIS, PC A99/MF A01.

The Nuclear Waste Policy Act of 1982 (NWPA) tasked the US Department of Energy (DOE) with establishing and operating a comprehensive, integrated system for disposal of the nations spent nuclear fuel and high-level radioactive waste and established the Office of Civilian Radioactive Waste Management (OCRWM) within DOE to fulfill that responsibility. A key component of the disposal program is the development and operation of a transportation system to move the waste from its present locations to disposal facilities. A fleet of casks capable of transporting the waste by truck, rail, or barge is being developed. As a result of an agreement between DOE and the Nuclear Regulatory Commission (NRC), each cask must be certified by the NRC. To meet these requirements, OCRWM is undertaking a program to design, test, certify, and fabricate a variety of cask systems. Design verification tests will be performed by the cask contractor to demonstrate design safety and to aid in cask certification by the NRC. During Type B packaging design verification testing designers may verify analytical calculations with instrumentation data. Many packages are tested with accelerometers and strain gages, collectively known as transducers, that measure structural response. Accelerometers measure acceleration and strain gages measure surface strain at the mounted location. This paper describes a method developed for OCRWM to evaluate various transducers of these two types that have been suggested for use in design verification testing. Typically transducers are characterized by the manufacturer under laboratory conditions. In this program ruggedness, failure frequency, repeatability, and manufacturers data under field and laboratory conditions were investigated.

20058 (CONF-890631–Vol.3, pp. 1553-1562) **The use of a thermal probe to determine the effective thermal conductivity of packaging contents.** Moya, J.L. (Sandia National Labs., Albuquerque, NM (USA)); Acton, R.U. Oak Ridge National Lab., TN (USA). [1989]. DOE Contract AC04-76DP00789. From International symposium on packaging and transportation of radioactive materials; Washington, DC (USA); 11-16 Jun 1989. In *The 9th international symposium on the packaging and transportation of radioactive materials. Proceedings: Volume 3.* Order Number DE90004449. Available from NTIS, PC A99/MF A01.

Contact-handled transuranic (CH-TRU) waste materials are nonradioactive items contaminated with alpha-emitting transuranium radionuclides. The most common transuranium radionuclides in the waste are plutonium and associated daughter products. These contaminants are usually in the form of oxides and are embedded, trapped, or otherwise attached to a variety of inert host or parent materials. Due to the high efficiencies of the recovery process, the actual contaminants are normally small in size and the contaminants remaining in the waste are usually well attached to their host. The TRU waste is typically sealed in plastic bags which, in turn, are placed within cans or other containers and are subsequently placed in 55-gallon steel drums with polyethylene liners. These procedures prepare the waste for transport and storage and reduce the possibility of contaminant release. Department of Transportation Regulation require that there will be no mixture of gases and vapors in the package which could, through any credible spontaneous increase of heat or pressure or through an explosion, significantly reduce the effectiveness of the packaging. Since many CH-TRU wastes produce gases, the designers of radioactive transport containers must consider the consequences of gas generation to ensure the safe operation of transport containers. During transport, gases are primarily generated in CH-TRU waste through three mechanisms: radiolysis, bacteriological decay, and thermal degradation. Radiolysis of organic materials, such as cellulosics, plastic, and oil, generates hydrogen, carbon dioxide, and carbon monoxide and depletes oxygen. Bacteriological decay of organic materials produces carbon dioxide or methane.

20059 (CONF-890631–Vol.3, pp. 1671-1677) **Design verification testing.** Madsen, M.M. (Sandia National Labs., Albuquerque, NM (USA)); Uncapher, W.L. Oak Ridge National Lab., TN (USA). [1989]. From International symposium on packaging and transportation of radioactive materials; Washington, DC (USA); 11-16 Jun 1989. In *The 9th international symposium on the packaging and transportation of radioactive materials. Proceedings: Volume 3.* Order Number DE90004449. Available from NTIS, PC A99/MF A01.

Type B packagings for transporting radioactive materials are required to survive exposures to environments in accordance with provisions of Title 10 Code of Federal Regulations Part 71. Testing, analyses, or a combination of testing and analysis may be used to demonstrate compliance with the normal and hypothetical accident conditions. This paper will discuss drop and puncture design verification testing. The extensive scale model design verification testing program conducted by Sandia National laboratories (SNL) to evaluate the structural response of the Defense High Level (DHLW) truck transportation cask will be used as an example. General aspects of design of the scale model, drop orientations, instrumentation, photography, nondestructive evaluations (NDE), data evaluations, test plans, and quality assurance can be applied to other design verification programs.

20060 (CONF-890631–Vol.3, pp. 1678-1685) **1/3-scale model testing program.** Yoshimura, H.R. (Sandia National Labs., Albuquerque, NM (USA)); Attaway, S.W.; Bronowski, D.R.; Uncapher, W.L.; Huerta, M.; Abbott, D.G. Oak Ridge National Lab., TN (USA).

[1989]. From International symposium on packaging and transportation of radioactive materials; Washington, DC (USA); 11-16 Jun 1989. In *The 9th international symposium on the packaging and transportation of radioactive materials. Proceedings: Volume 3.* Order Number DE90004449. Available from NTIS, PC A99/MF A01.

This paper describes the drop testing of a one-third scale model transport cask system. Two casks were supplied by Transnuclear, Inc. (TN) to demonstrate dual purpose shipping/storage casks. These casks will be used to ship spent fuel from DOEs West Valley demonstration project in New York to the Idaho National Engineering Laboratory (INEL) for long term spent fuel dry storage demonstration. As part of the certification process, one-third scale model tests were performed to obtain experimental data. Two 9-m (30-ft) drop tests were conducted on a mass model of the cask body and scaled balsa and redwood filled impact limiters. In the first test, the cask system was tested in an end-on configuration. In the second test, the system was tested in a slap-down configuration where the axis of the cask was oriented at a 10 degree angle with the horizontal. Slap-down occurs for shallow angle drops where the primary impact at one end of the cask is followed by a secondary impact at the other end. The objectives of the testing program were to (1) obtain deceleration and displacement information for the cask and impact limiter system, (2) obtain dynamic force-displacement data for the impact limiters, (3) verify the integrity of the impact limiter retention system, and (4) examine the crush behavior of the limiters. This paper describes both test results in terms of measured deceleration, post test deformation measurements, and the general structural response of the system.

20061 (CONF-890631–Vol.3, pp. 1796-1802) **BR-100 spent fuel shipping cask.** McGuinn, E.J. (B and W Fuel Co., Lynchburg, VA (USA)); Childress, P.C.; Bochard, C.M. Oak Ridge National Lab., TN (USA). [1989]. DOE Contract AC07-88ID12701. From International symposium on packaging and transportation of radioactive materials; Washington, DC (USA); 11-16 Jun 1989. In *The 9th international symposium on the packaging and transportation of radioactive materials. Proceedings: Volume 3.* Order Number DE90004449. Available from NTIS, PC A99/MF A01.

The Nuclear Waste Policy Act of 1982 mandates that the US Department of Energy (DOE) establish an integrated waste management system leading to permanent, deep geologic disposal of spent nuclear fuel and high-level wastes. The transportation component of this system must satisfy requirements of safety, reliability, and schedule. System interfaces include the utilities reactor sites and other radioactive waste generators, the monitored retrievable storage (MRS) facilities, and the receiving facilities at the geologic repositories. As part of this program, B and W Fuel Company (BWFC) is under contract to the DOE to develop a Nuclear Regulatory Commission (NRC) certified shipping cask for spent nuclear fuel that is compatible with both rail and barge modes of transportation. The BR-100, shown in Figure 1, is a 100-ton rail/barge cask with a capacity of 21 PWR or 52 BWR 10-year cooled, intact fuel assemblies. Optional basket designs may permit licensing the cask for a variety of payloads, including consolidated fuel. The BR-100 uses a multi-layer cask body construction with lead gamma shielding and borated concrete neutron shielding sandwiched between stainless steel shells. Copper fins embedded in the concrete enhance the heat transfer through the concrete during normal operations, while during the fire accident, localized release of steam formed on the outside of the concrete retards the heat flow into the cask. The thickness of lead and concrete layers are established by the shielding analysis so that the external dose rates for the cask packaging will be below the limits set by 10CFR71. The all-aluminum basket consists of a central cluster of square fuel cells surrounded by circle-to-square formers, which provide lateral support and an efficient heat path. The last section contains a description of the cask design and an outline of the analytical evaluations.

20062 (CONF-890631–Vol.3, pp. 1811-1818) **140-B rail/barge spent fuel cask development.** Doman, D.R. (Nuclear Packaging, Inc., Federal Way, WA (USA)); Kee, A.T. Oak Ridge National Lab., TN (USA). [1989]. From International symposium on packaging and transportation of radioactive materials; Washington, DC (USA); 11-16 Jun 1989. In *The 9th international symposium on the packaging and transportation of radioactive materials. Proceedings: Volume 3.* Order Number DE90004449. Available from NTIS, PC A99/MF A01.

Development of the 90,700 Kg (100 ton) 140-B Rail/Barge Cask for OCRWM requires satisfying at least the following simultaneous and sometimes conflicting requirements. The payload of PWR and BWR fuel assemblies and/or consolidated fuel rods should be as large as possible to minimize life cycle costs and total radiation exposures for the entire transportation system. This may mean that the cask cost alone may not be the minimum. Exceed neither the 90,700 Kg crane hook capacity or the 119,300 Kg (263,000 pound) railcar gross weight limits. Provide a thermal path to dissipate heat outward from fuel assemblies but also not conduct enough heat inward during the hypothetical accident fire to exceed fuel pin peak cladding or seal temperatures in either case. Interface satisfactorily with a large number of utility and repository facilities and equipment with rapid turnaround times while keeping radiation exposures of personnel and the public as low as reasonably achievable (ALARA). Assure subcriticality with a large number and variety of fuel assembly designs in fuel pool loading, shipment or accident conditions. Fuels may be enriched up to 4-$\frac{1}{2}$%. Be licensed by NRC to 10 CFR 71, requiring survival of hypothetical accident drops, puncture tests, and fires without loss of containment or damage to fuel. Withstand submergence requirements of IAEA Safety Series 6. The preliminary design of the 140-B Rail/Barge Cask is about 60% complete and incorporates several innovative features which extend current cask design techniques.

20063 (CONF-900406–12) **Investigation of burnup credit allowance in the criticality safety evaluation of spent fuel casks.** Lake, W.H. (USDOE, Washington, DC (USA)); Sanders, T.L.; Parks, C.V. Oak Ridge National Lab., TN (USA). [1990]. 16p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC05-84OR21400. From International conference for high-level radioactive waste management; Las Vegas, NV (USA); 8-12 Apr 1990. Order Number DE90005447. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This presentation discusses work in progress on criticality analysis verification for designs which take account of the burnup and age of transported fuel. The work includes verification of cross section data, correlation with experiments, proper extension of the methods into regimes not covered by experiments, establishing adequate reactivity margins, and complete documentation of the project. Recommendations for safe operational procedures are included, as well as a discussion of the economic and safety benefits of such designs.

20064 (CONF-900406–31) **Size and transportation capabilities of the existing US cask fleet.** Danese, F.L. (Science Applications International Corp., Oak Ridge, TN (USA)); Johnson, P.E.; Joy, D.S. Oak Ridge National Lab., TN (USA). [1990]. 9p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC05-84OR21400. From International conference for high-level radioactive waste management; Las Vegas, NV (USA); 8-12 Apr 1990. Order Number DE90007051. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This study investigates the current spent nuclear fuel cask fleet capability in the United States. In addition, it assesses the degree to which the current fleet would be available, as a contingency, until proposed Office of Civilian Radioactive Waste Management casks become operational. A limited fleet of ten spent fuel transportation casks is found to be readily available for use in Federal waste management efforts over the next decade.

20065 (CONF-900464–4) **A human factors testbed for ground-vehicle telerobotics research.** Corbett, G.K. (Oak Ridge National Lab., TN (USA)); Killough, S.M.; Richardson, B.S.; Herman, M. Oak Ridge National Lab., TN (USA). [1990]. 4p. Sponsored by U.S. Department of Defense. DOE Contract AC05-84OR21400. From IEEE Southeastcon; New Orleans, LA (USA); 1-4 Apr 1990. Order Number DE90006618. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A human factors testbed has been designed for the US Army Human Engineering Laboratory to experiment in the area of remote control of wheeled vehicles. The testbed's capabilities have been

demonstrated by remotely driving a high maneuverability and mobility wheeled vehicle (HMMWV). Details of testbed design and experiments are presented. 4 refs., 3 figs.

20066 (CONF-9004135–1) **Implementation of an interactive, knowledge-based assistant for diagnosis and repair of complex control systems.** Roberts, A.G.; Broadaway, E.R.; Jefferis, J.A. Oak Ridge National Lab., TN (USA). [1990]. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-84OR21400. From ESD expert system conference; Detroit, MI (USA); 3-5 Apr 1990. Order Number DE90007113. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The advent of the automated factory has resulted in an overwhelming amount of information and expertise required by factory maintenance personnel. To meet this need, a knowledge base was constructed to provide information on a particular system. It incorporates manufacturers' manuals, detailed procedural instruction, still-frame video pictures, and inference engine rules. This knowledge base was created and used with the aid of an object-oriented authoring system developed at the Oak Ridge National Laboratory. Experience gained from the initial implementation is discussed in relation to construction of knowledge bases in general. 6 refs., 4 figs.

20067 (DOE/ER–0436) **Summaries of FY 1989 engineering research.** USDOE Office of Energy Research, Washington, DC (USA). Engineering and Geosciences Div. 1989. 63p. Sponsored by U.S. DOE Energy Research. Order Number DE90006449. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The individual project summaries follow the program overview. The summaries are ordered alphabetically by name of institution and so the table of contents lists all the institutions at which were sponsored in fiscal year 1989. The projects are numbered sequentially for individual identification in the indexes. Each project entry begins with an institutional-departmental heading. The project number precedes the capitalized project title. The names of investigators are listed immediately below the title. The funding level for fiscal year 1989 appears to the right of title; it is followed by the budget activity number (e.g., 01-A). These numbers categorize the projects for budgetary purposes and the categories are described in the budget number index. The year in which either the project began or was renewed and the anticipated duration in years are indicated respectively by the first two and last digits of the sequence directly below the budget activity number (e.g., 88-). The summary description of the project completes the entry. 2 figs.

20068 (EEG–28) **Radiation shielding in the hot cell facility at the Waste Isolation Pilot Plant: A review.** Knowles, H.B. Environmental Evaluation Group, Albuquerque, NM (USA). Nov 1984. 54p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-89AL58309. Order Number DE90007367. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

The purpose of the Environmental Evaluation Group (EEG) is to conduct an independent technical evaluation of the potential radiation exposure to people from the proposed Federal radioactive Waste Isolation Pilot Plant (WIPP) near Carlsbad, in order to protect the public health and safety and ensure that there is minimal environmental degradation. Analyses are conducted of available data concerning the proposed site, the design of the repository, its planned operation, and its long-term stability. These analyses include assessments of reports issued by the US Department of Energy (DOE) and its contractors, other Federal agencies and organizations, as they relate to the potential health, safety and environmental impacts from WIPP. 5 refs., 3 figs., 4 tabs.

20069 (EGG-M–89478) **Spent fuel storage cask testing and operational experience at the Idaho National Engineering Laboratory.** Eslinger, L.E.; Schmitt, R.C. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 6p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC07-76ID01570. (CONF-891103–66: Winter meeting of the American Nuclear Society, San Francisco, CA (USA), 26-30 Nov 1989). Order Number DE90006958. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Spent fuel research and development demonstrations and associated transportation activities are being performed for DOE's Office of Civilian Radioactive Waste Management (OCRWM) as a part of the Storage Cask Performance Testing Programs. The cask testing program at federal sites and other locations supports the Nuclear Waste Policy Act (NWPA) and Department of Energy (DOE) objective for cooperative demonstrations with the cask vendors and utilities for development of at-reactor dry cask storage capabilities for spent nuclear fuel assemblies. Research and development programs for storage cask performance testing and operation were conducted. Testing was conducted at the INEL's Test Area North (TAN) cask-testing facility and consisted of pretest preparations, performance testing, and post-test activities. TAN was determined to be the appropriate federal facility in which to conduct these activities because of the availability of experienced staff, hot and cold test development areas, and the support experienced staff, hot and cold test development areas, and the support facilities needed to receive and store commercial spent fuel assemblies. 4 refs.

20070 (HAZ–CE02855, pp. 214-231) **Considerations in underground storage tank/piping management.** O'Connor, M.J. (O'Connor Associates Environmental Inc., Calgary, AB (Canada)); Agar, J.G.; King, R.D.; Hawkins, J.G. Haztech Canada, Edmonton, AB (Canada). 1988. (CONF-8810478–: Haztech western Canada: hazardous waste management and environmental control conference, Edmonton (Canada), 5-6 Oct 1988; CE–02855). In *Haztech Western Canada '88: Hazardous waste management and environmental control conference proceedings.* Available from Haztech Canada, 4936-87th St., no. 26, Edmonton, AB, CAN T6E 5W3. Prices: $50.00 CAN.

It is estimated that there may be 200,000 underground storage tanks and associated piping systems in Canada. Based on comparable studies made in the U.S.A., perhaps 10% of these tank/piping systems are leaking. The location of the tank/piping system is discussed: influence of the geology of the site, of the direction of the ground water flow, of the depth to the ground water level, and proximity to sensitive facilities (such as water wells or sewers) and to other potential sources of pollution (problem of liability). The tank/piping system specifications are discussed: compatibility with the product to be stored, with the subsurface environment and with each other, selection of tank and piping systems (metals or fiberglass reinforced plastics, suction or pressure), and installation (with a list of causes of failure, especially at joints). Loss control procedures are discussed: tank testing, monitoring methods, and secondary containment. Not even the smallest detail, in a leak prevention program, can be overlooked. 5 refs., 3 figs., 2 tabs.

20071 (N–90-12786, pp. 141-149) **A closed-cycle refrigerator for cooling maser amplifiers below 4 Kelvin.** Britcliffe, M. Jet Propulsion Lab., Pasadena, CA (USA). Aug 1989. (NASA-CR–185093;JPL-TDA-PR–42-98;NAS–1.26:185093). In *The Telecommunications and Data Acquisition Report.* Available from NTIS, PC A11/MF A02.

A helium refrigerator utilizing the Gifford-McMahon/Joule-Thomson (GM/JT) cycle was designed and tested to demonstrate the feasibility of using small closed-cycle refrigerators as an alternative to batch-filled cryostats for operating temperatures below 4 K. The systems could be used to cool low-noise microwave maser amplifiers located in large parabolic antennas. These antennas tilt vertically, making conventional liquid-filled dewars difficult to use. The system could also be used for a non-tilting beam waveguide antenna to reduce the helium consumption of a liquid helium cryostat. The prototype system is adjustable to provide 700 mW of cooling at 2.5 K to 3 W at 4.3 K. Performance of the unit is not significantly affected by physical orientation. The volume occupied by the refrigerator is less than 0.1 cu m. Two JT expansion stages are used to maximize cooling capacity per unit mass flow. The heat exchangers were designed to produce minimum pressure drop in the return gas stream. Pressure drop for the entire JT return circuit is less than 5 kpa at a mass flow of 0.06 g/sec when operating at 2.5 K.

20072 (N–90-12935) **Cryostatless high temperature supercurrent bearings for rocket engine turbopumps.** Rao, D.K.; Dill, J.F. Mechanical Technology, Inc., Latham, NY (USA). Sep 1989. 97p. (NASA-CR–183807;NAS–1.26:183807;MTI–89TR40). Available from NTIS, PC A05/MF A01.

The rocket engine systems examined include SSME, ALS, and CTV systems. The liquid hydrogen turbopumps in the SSME and

ALS vehicle systems are identified as potentially attractive candidates for development of Supercurrent Bearings since the temperatures around the bearings is about 30 K, which is considerably lower than the 95 K transition temperatures of HTS materials. At these temperatures, the current HTS materials are shown to be capable of developing significantly higher current densities. This higher current density capability makes the development of supercurrent bearings for rocket engines an attractive proposition. These supercurrent bearings are also shown to offer significant advantages over conventional bearings used in rocket engines. They can increase the life and reliability over rolling element bearings because of noncontact operation. They offer lower power loss over conventional fluid film bearings. Compared to conventional magnetic bearings, they can reduce the weight of controllers significantly, and require lower power because of the use of persistent currents. In addition, four technology areas that require further attention have been identified. These are: Supercurrent Bearing Conceptual Design Verification; HTS Magnet Fabrication and Testing; Cryosensors and Controller Development; and Rocket Engine Environmental Compatibility Testing.

20073 (NEI-NO–101, pp. 44) **Developing an 18-3/4"-15,000 psi ram type blowout preventer.** Jones, M.R. (Koomey Inc., Brookshire, TX (USA)). Norsk Petroleumsforening, Oslo (Norway). 1983. (CONF-8310456–: 1. Northern European drilling conference, Kristiansand (Norway), 24-26 Oct 1983). In *First Northern European drilling conference, Kristiansand, Norway, October 24-26, 1983.* Order Number DE90748476. Available from NTIS (US Sales Only), PC A21/MF A01.

The present paper gives the design procedure for a 15,000 psi ram type blowout preventer. 10 figs.

20074 (ORNL/TM–11016) **Non-LWR and special LWR spent fuels: Characteristics and criticality aspects of packaging and disposal.** Salmon, R.; Notz, K.J. Oak Ridge National Lab., TN (USA). Jan 1990. 88p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC05-84OR21400. Order Number DE90006444. Available from NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

Two important categories of potential repository wastes, non-LWR spent fuels and special LWR spent fuels, were evaluated regarding their future quantities and packaging requirements, including criticality aspects. Assuming that canisters similar to those planned for vitrified high-level waste and conventional LWR fuel assemblies prove to be acceptable for these fuels, it is estimated that about 1400 such canisters will be needed for the non-LWR and special LWR spent fuels on hand and projected through the year 2020. Approximately half of these canisters are for HTGR spent fuel, a quarter are for TMI-2 spent fuel and core debris, and the balance are for fuels from a score of diverse sources. About two thirds of these spent fuels can be accommodated in extended vitrified HLW-size canisters and the remainder will fit into canisters proposed for use in a tuff repository. Since many of these fuels are of higher enrichment and/or lower burnup than standard LWR spent fuel, estimation of the number of fuel assemblies that could be safely placed in a canister required preliminary calculations of neutron multiplication factors to ensure non-criticality. These estimates showed that the canister configurations used would provide more than adequate volume for the neutron poisons needed for this purpose. 36 refs., 19 figs., 20 tabs.

20075 (SAND–88-3402) **Measurement capabilities of the Primary Standards Laboratory.** Odom, M.K. (ed.). Sandia National Labs., Albuquerque, NM (USA). Aug 1989. 63p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90006431. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This report lists and describes the principal measurement capabilities of the Primary Standards Laboratory. The measurement capabilities are those of the present and the near future, expressed in terms of primary standards, standards calibrated, and uncertainties in a given range. 33 figs., 6 tabs.

20076 (SAND–89-0209/3) **An adaptable modular Safeguards Control and Communications System: Version 2, Operator's manual.** Quintana, G. Sandia National Labs., Albuquerque, NM (USA). Jan 1990. 90p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90008114. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The documentation provided in this manual is intended to assist suppliers in developing a commercial product. The operating procedures described herein can be supplied to a wide range of applications where input data is processed and output controls are desired. The detailed operating instructions are for a vision of the Safeguards Control and Communications System (SCCS). The SCCS was developed for use in alarm communications and display systems. These systems can be used in security systems, for fire protection, or in other systems where annunciation of information is desired. In order to provide a basis for the operating instructions that follow, the manual with a description of the system hardware, concentrating on the hardware at the SCCS operator's console. The hardware used in the SCCS consists almost entirely of commercially available equipment. The manual then provides detailed operating instructions for both normal and emergency operating conditions.

20077 (SAND–89-0753C) **Extending terrestrial mobile robotics to a proposed lunar base.** Klarer, P.R. Sandia National Labs., Albuquerque, NM (USA). [1989]. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900442–1: Engineering, construction and operations for space, Albuquerque, NM (USA), Apr 1990). Order Number DE89016179. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The National Aeronautics and Space Administration (NASA) has recently been conducting studies regarding missions to establish permanent manned facilities either on Earth's moon or on Mars sometime in the next few decades. This paper addresses issues associated with the operation of manned, teleoperated and autonomous land vehicles to be used in the lunar environment. Current capabilities in teleoperation and autonomous navigation for land vehicles in the terrestrial environment are discussed, as are the technology issues and new capabilities required to extend the current capabilities to a lunar operating environment. 16 refs.

20078 (SAND–89-2052C) **Method for determining the fuel contribution to the source term in shipping casks.** Rashid, Y.R. (Anatech International Corp., La Jolla, CA (USA)); Sanders, T.L.; Lake, W.H. Sandia National Labs., Albuquerque, NM (USA). Aug 1989. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900406–2: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90000844. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A cask containment system can generally be designed from two perspectives – either the cask and its associated hardware alone are assumed to provide containment or the contents of the cask, in this case the spent fuel, are also considered part of the containment system. In the latter approach, known as a source-term methodology, some credit is derived for those contents based on their material, physical, or chemical properties that tend to limit or inhibit radionuclide "release." The former approach, in which no such credit is taken, is generally called a "leaktight" design basis. While previous containment analyses for transport casks in the US have used both leaktight and source term approaches, recent practice on the part of both designers and regulators has been to rely totally on the cask for containment. This evolution to a "leaktight" criterion primarily resulted from the lack of a standardized source term characterization methodology that might have addressed specific properties of the cask contents. 3 refs., 6 figs.

20079 (SAND–89-2250C) **The role of sensor directed, model-based control in robotic handling of nuclear waste casks and materials.** Bennett, P.C. Sandia National Labs., Albuquerque, NM (USA). Dec 1989. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (TTC–0938;CONF-900406–18: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90006019. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper discusses the results from several projects at Sandia National Laboratories investigating the application of intelligent machine technologies to remote handling of nuclear waste casks and materials. In particular, the importance of computer models of the robot, its environment and their interactions is focused upon. Integration of such models into the sensor based control of robot systems results in significant increases in the capabilities of commercial robots by allowing tuning of robot performance to the task. 7 refs., 4 figs.

20080 (SAND–89-2263C) **Materials selection issues for structural components of transportation casks.** Sorenson, K.B.; Salzbrenner, R.; Stephens, J.J. Jr. Sandia National Labs., Albuquerque, NM (USA). 1989. 10p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC04-76DP00789. (CONF-900406–30: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90006809. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The Oak Ridge National Laboratory (ORNL) Waste Handling and Packaging Plant is developing a microwave process to reduce and solidify remote-handled transuranic (RH-TRU) liquids and sludges presently stored in large tanks at ORNL. Testing has recently begun on an in-drum microwave process using nonradioactive RH-TRU surrogates. The microwave process development effort has focused on an in-drum process to dry the RH-TRU liquids and sludges in the final storage container and then melt the salt residues to form a solid monolith. A 1/3-scale proprietary microwave applicator was designed, fabricated, and tested to demonstrate the essential features of the microwave design and to provide input into the design of the full-scale applicator. The final wasteform meets the waste acceptance criteria for the Waste Isolation Pilot Plant. 7 refs., 1 fig., 1 tab.

20081 (SAND–90-0334C) **Use of chaotic and random vibrations to generate high frequency test inputs: Part 1, The system.** Gregory, D.L.; Paez, T.L. Sandia National Labs., Albuquerque, NM (USA). [1990]. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900479–5: 36. Institute of Environmental Science annual technology meeting, New Orleans, LA (USA), 23-27 Apr 1990). Order Number DE90007412. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper and a companion paper show the traditional limits on amplitude and frequency that can be generated in a laboratory test on a vibration exciter can be substantially extended. This is accomplished by attaching a device to the shaker that permits controlled metal to metal impacts that generate high frequency, high acceleration environment on a test surface. A companion paper (Reference 1) shows that a sinusoidal or random shaker input can be used to generate a random vibration environment on the test surface. This paper derives the three response components that occur on the test surface due to an impact on the bottom surface and the base driven response from the shaker input. These response components are used to generate impulse response functions and frequency response functions which are used in the companion paper to derive power spectral density functions for the overall response. 9 refs., 8 figs.

20082 (SAND–90-0335C) **Use of chaotic and random vibrations to generate high frequency test inputs: Part 2, Chaotic vibrations.** Paez, T.L.; Gregory, D.L. Sandia National Labs., Albuquerque, NM (USA). [1990]. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900479–2: 36. Institute of Environmental Science annual technology meeting, New Orleans, LA (USA), 23-27 Apr 1990). Order Number DE90007153. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper and a companion paper show that the traditional limits on amplitude and frequency that can be generated in a laboratory test on a vibration exciter can be substantially extended. This is accomplished by attaching a device to the shaker that permits controlled metal to metal impacts that generate a high acceleration, high frequency environment on a test surface. A companion paper derives some of the mechanical relations for the system. This paper shows that a sinusoidal shaker input can be used to excite deterministic chaotic dynamics of the system yielding a random vibration environment on the test surface, or a random motion of the shaker can be used to generate a random vibration environment on the test surface. Numerical examples are presented to show the kind of environments that can be generated in this system. 9 refs., 9 figs.

20083 (SFB-210/A–42, pp. 177-192) **Mathematical simulation of the dynamics of freely laid pipelines with non-steady flow through them - measurements and numerical simulation of measurements.** Thielen, H.; Buermann, W.; Janson, H.; Feser, G. Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke. Mar 1988. (In German). In *Work and result report of Special Research Area 210 for the years 1985-1987.* Available from Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke. Available from Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke.

The basis for the investigation of the dynamic support forces are the expanded pressure surge equations which are analytically solved numerically and in individual cases, with the aid of the characteristic method. The supports, compensators, elbows etc., are included as compatibility or boundary conditions. Because of the great variety of pipeline systems (for examples in chemical plants), there is a classification of cases, i.e.: of the compatibility and boundary conditions at the beginning of the theoretical investigations, which follows the measurements. The measurements are of the internal pressure, the longitudinal acceleration and also the extension of the pipe walls, in order to make a comparison of the theoretical support forces with the dynamic support forces determined from the measured accelerations and the measured extensions possible. (orig./KW).

20084 (WHC-SA–0689) **High-impact concrete for fill in US Department of Transportation type shipping containers.** Greenhalgh, W.O.; Cash, R.J. Westinghouse Hanford Co., Richland, WA (USA). Jan 1990. 14p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-87RL10930. (CONF-900210–16: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90007612. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report describes the use of light-weight, high-impact concrete in US Department of Transporation-type shipments. The formulations described are substantially lighter in weight (20 to 50 percent) than construction concrete, but product test specimens generally yielded superior impact characteristics. The use of this speciality concrete for container fill, encapsulations, or liquid-waste solidification can be advantageous. Use of the material for container or cask construction has the advantage of lighter weight for easier handling, and the container consistently exhibits better performance on drop tests. High-impact concrete does have the disadvantage of less gamma radiation shielding per volume, but some formulation changes discussed in this report can be used to prepare better shielding concrete. Test characteristics of high-impact concrete are included. 3 refs., 8 figs., 7 tabs.

4204 Heat Transfer and Fluid Flow

Refer also to citation(s) 19370, 19558, 19571, 19573, 19593, 19945, 20102

20085 (CONF-880802–12) **The Stochastic Flamelet Model of turbulent premixed combustion.** Pope, S.B.; Cheng, W.K. Massachusetts Inst. of Tech., Cambridge, MA (USA). [1988]. 21p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER13553;AC02-83ER13038. From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988. Order Number DE90006313. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A new stochastic model is presented and used to calculate the properties of turbulent premixed flames in the flame-sheet regime. The flame sheet is represented statistically by infinitesimal flamelets, each of which is characterized by its position, its unit

normal vector, and its (infinitesimal) area. The evolution of the position and normal are completely determined by the fluid velocity and its spatial derivatives following the flamelet, which are modelled by stochastic processes. The flamelet area changes by stretching caused by velocity gradients, by the propagation of cusps, and because of curvature. An additional model is developed to account for the latter two mechanisms. The Stochastic Flamelet Model is used in conjunction with the joint pdf approach to make calculations of non-stationary, statistically-plane turbulent premixed flames. These calculations demonstrate the practicality of the method and illustrate its attributes. Because it contains a natural and comprehensive statistical description of the flame sheet, the model allows the essential physical processes to be incorporated in a straightforward manner. 22 refs., 6 figs.

20086 (DOE/ER/13132–T3) **Coherent structure-reflective turbulence modeling of complex shear flows.** Hokenson (G.J.), Los Angeles, CA (USA). Apr 1985. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-83ER13132. Order Number DE90007380. Available from NTIS, PC A02/MF A01 - OSTI.

The limitations of two-equation turbulence models which this work has focused on qualitatively involve the appearance of non-turbulent fluctuations, a distinct multiple-scale turbulence nature and interactions between the non-turbulent fluctuations and the large-scale (spatially-) coherent turbulent structure.

20087 (EGG-EAST–8491) **Dryout stability and inception at low flowrates.** Duffey, R.B.; Hughes, E.D. EG and G Idaho, Inc., Idaho Falls, ID (USA). Nov 1989. 32p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90006955. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A theoretical model for the heat flux required to maintain a stable hot patch on a heated surface cooled by a falling liquid film is developed. The dryout patch may be initially formed by hydrodynamic processes within the liquid film, but a higher heat flux is required to maintain the patch at an equilibrium size, neither growing or shrinking. The theoretical model is based on an analytical solution of the two-dimension heat equation with boundary conditions supplied by heat transfer coefficient correlations appropriate to the fluid conditions at the hot dry patch and at the wet region from the patch. The analytical results show that the heat flux required to maintain a dry patch is a function of only these correlations. This functional dependency has also been observed for the physically similar processes associated with quenching of an initially hot surface by a falling (or rising) liquid film. Using physically reasonable correlation forms for the dry patch and wet region heat transfer correlations, the heat flux is expressed as a function of the liquid film Reynolds number. The experimental data were obtained for liquid films falling on the outside of heated rods with heated lengths from 0.50 m to 3.66 m and heated diameters from 7.5 mm to 52.0 mm. The liquid film Reynolds number for the experimental data ranges from about 100 to about 10,000 and the heat flux ranges from about 1 kW/m^2 to about 300 kW/m^2. 19 refs., 3 figs.

20088 (JAERI-M–89-127) **Effect of two-phase mixing coefficient on subchannel analysis and CHF prediction.** Iwamura, Takamichi (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Okubo, Tsutomu; Suemura, Takayuki; Hiraga, Fujio; Murao, Yoshio. Japan Atomic Energy Research Inst., Tokyo (Japan). Sep 1989. 53p. (In Japanese). Order Number DE90749880. Available from NTIS (US Sales Only), PC A04/MF A01.

Turbulent mixing coefficients obtained from single-phase mixing experiments were also used for a two-phase flow condition in previous subchannel analyses. In the present study, the enhancement of flow mixing between subchannels under two-phase flow condition was taken into account so as to improve the predictive capability of critical heat flux (CHF) in a rod bundle. Reviewing available literatures on subchannel flow mixing experiments under two-phase flow conditions, it was revealed that the mixing flow rate is flow regime dependant. That is, the mixing flow rate increases with void fraction in a bubbly flow regime and reaches a peak value in a slug/churn flow regime then decreases in an annular flow regime. An empirical correlation of two-phase mixing coefficient was introduced as a function of void fraction based on Sadatomi's experimental data. The correlation was implemented into the COBRA-IV-I subchannel code. Entalpy distribution of Rowe and Angle's mixing experiments under boiling two-phase flow conditions were reasonably well predicted with this code. Using the two-phase mixing correlation together with a KfK CHF correlation, a steady-state CHF under a high void fraction was predicted to increase by about 5% in comparison to the previous single-phase mixing assumption. Under a steady-state condition, the safety margin due to the two-phase mixing enhancement effect was evaluated to be within a predictive capability of the CHF correlation. (author).

20089 (N–90-12503) **Research in natural laminar flow and laminar-flow control, part 1.** Hefner, J.N.; Sabo, F.E. National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center. Dec 1987. vp. (NASA-CP–2487-PT-1;L–16350-PT-1;NAS–1.55:2487-PT-1;CONF-8703331–: Research in natural laminar flow and laminar-flow control conference, Hampton, VA (USA), 16-19 Mar 1987). Available from NTIS, PC A14/MF A02.

Since the mid 1970's, NASA, industry, and universities have worked together to conduct important research focused at developing laminar flow technology that could reduce fuel consumption for general aviation, commuter, and transport aircraft by as much as 40 to 50 percent. The symposium was planned in view of the recent accomplishments within the areas of laminar flow control and natural laminar flow, and the potential benefits of laminar flow technology to the civil and military aircraft communities in the United States. Included were technical sessions on advanced theory and design tool development; wind tunnel and flight research; transition measurement and detection techniques; low and high Reynolds number research; and subsonic and supersonic research.

20090 (N–90-12519) **Research in natural laminar flow and laminar-flow control, part 2.** Hefner, J.N.; Sabo, F.E. National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center. Dec 1987. vp. (NASA-CP–2487-PT-2;L–16350-PT-2;NAS–1.55:2487-PT-2;CONF-8703331–: Research in natural laminar flow and laminar-flow control conference, Hampton, VA (USA), 16-19 Mar 1987). Available from NTIS, PC A15/MF A02.

Part 2 of the Symposium proceedings includes papers addressing various topics in basic wind tunnel research/techniques and computational transitional research. Specific topics include: advanced measurement techniques; laminar flow control; Tollmien-Schlichting wave characteristics; boundary layer transition; flow visualization; wind tunnel tests; flight tests; boundary layer equations; swept wings; and skin friction.

20091 (N–90-12519, pp. 381-388) **Remote detection of boundary-layer transition by an optical system.** Hall, R.M. (Spectron Development Labs., Inc., Costa Mesa, CA (USA)); Azzazy, M.; Modarress, D. National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center. Dec 1987. (NASA-CP–2487-PT-2;L–16350-PT-2;NAS–1.55:2487-PT-2;CONF-8703331–: Research in natural laminar flow and laminar-flow control conference, Hampton, VA (USA), 16-19 Mar 1987). In *Research in natural laminar flow and laminar-flow control, part 2.* Available from NTIS, PC A15/MF A02.

This instrument development program was funded because of the urgent need to measure boundary-layer transition in wind tunnels. In the course of this development program, a prototype was designed, built, and tested. Recent transonic experiments in the Boeing Model Transonic Wind Tunnel show that the interferometer results correlate very well with sublimating chemical tests.

20092 (N–90-12539) **Research in natural laminar flow and laminar-flow control, part 3.** Hefner, J.N.; Sabo, F.E. National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center. Dec 1987. vp. (NASA-CP–2487-PT-3;L–16350-PT-3;NAS–1.55:2487-PT-3;CONF-8703331–: Research in natural laminar flow and laminar-flow control conference, Hampton, VA (USA), 16-19 Mar 1987). Available from NTIS, PC A17/MF A03.

Part 3 of the Symposium proceedings contains papers addressing advanced airfoil development, flight research experiments, and supersonic transition/laminar flow control research. Specific topics include the design and testing of natural laminar flow (NLF) airfoils, NLF wing gloves, and NLF nacelles; laminar boundary-layer stability over fuselage forebodies; the design of low noise supersonic/

hypersonic wind tunnels; and boundary layer instability mechanisms on swept leading edges at supersonic speeds.

20093 (PSI–51) **Dispersed flow film boiling: An investigation of the possibility to improve the models implemented in the NRC computer codes for the reflooding phase of the LOCA.** Andreani, M. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Yadigaroglu, G. Paul Scherrer Inst. (PSI), Villigen (Switzerland). Dec 1989. 63p. Order Number DE90617793. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

Dispersed flow film boiling is the heat transfer regime that occurs at high void fractions in a heated channel. The way this transfer mode is modelled in the NRC computer codes (RELAP5 and TRAC) and the validity of the assumption and empirical correlations used is discussed. An extensive review of the theoretical and experimental work related with heat transfer to highly dispersed mixtures reveals the basic deficiencies of these models: the investigation refers mostly to the typical conditions of low rate bottom reflooding, since the simulation of this physical situation by the computer codes has often showed poor results. The alternative models that are available in the literature are reviewed, and their merits and limits are highlighted. The modification that could improve the physics of the models implemented in the codes are identified. (author) 13 figs., 123 refs.

20094 (RFP–4280) **Constant temperature oil bath over/under temperature control.** Bell, B.E. Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant. 29 Dec 1989. 13p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-90DP62349. Order Number DE90008102. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

An oil bath cutoff device has been designed and developed for use at the Rocky Flats Standards Laboratory. Its purpose is to prevent inadvertent thermal runaway as experienced by other standards laboratories. This paper discusses the design, development, construction, theory, testing, and use of this device. It also shows how the "Keep It Simple" philosophy helped create an oil bath cutoff that is not only extremely portable but also easy to implement and use. 9 figs., 3 tabs.

4205 Materials Testing

Refer also to citation(s) 19344, 19552, 19575, 19579, 19603, 19604, 19605, 19606, 19607, 19712, 19781, 19788, 19789, 19790, 19883, 19905, 20069, 20081, 20141, 20223

20095 (EGG-M–89447) **Hydrogen assay foil counting system.** Rogers, J.W. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 7p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90007415. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The purpose of this seminar is to describe the measurements and analyses performed by the Hydrogen Assay Foil Counting System (HAFCS) in use at the Idaho National Engineering Laboratory. These measurements and analyses are related to the nondestructive assay of the hydrogen content of materials specimens using a "notched" neutron spectrum technique. The "notched" spectrum technique employs the way in which hydrogen atoms moderate neutrons in scattering collisions where the neutrons are thermalized or slowed down. A beam of neutrons from a "thermal" reactor is "tailored" by filtering the neutrons with cadmium and indium to produce a "notched" spectrum. This "notched" spectrum neutron beam is then used to activate a pair neutron detecting indium foils sandwiching a test material specimen containing hydrogen. The neutron moderation by the hydrogen causes differential activation in the foils which can be interpreted as a signal-to-noise (S/N) ratio that varies with the hydrogen content of the specimen. The 54.15 minute ^{116}In radioactivities of the foils are measured by NaI(Tl) scintillation counting equipment.

20096 (FhG-IzfP–840123-TW) **Development of higher-frequency broadband EMUS transducers (≥ 2 MHz) for the testing of surfaces or sub-surface areas of primary coolant circuit components. Final report.** Huebschen, G.; Wilbrand, A. Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung e.V., Saarbruecken (Germany, F.R.). Inst. fuer Zerstoerungsfreie Pruefverfahren. 30 May 1984. 60p. (In German). Available from Copy held by UB/TIB Hannover.

An EMUS phased array transducer for broadband excitation of higher-frequency Rayleigh waves (1.85 MHz) has been developed, in which the emitter and receiver windings are arranged in segments and are placed in V-position beneath a pole surface of an electromagnet with U-shaped core. The electric and acoustic properties of the transducer have been studied and the detecting efficiency has been tested in pieces with boreholes and notches. An edge echo from a distance of 70 mm at a band width of 150% produces a signal-to-noise ratio of 37 dB, and of 39 dB at a band width of 90%. The half-value width of the directional characteristic of emitter or receiver winding, resp., (aperture 12 mm) is 12.5deg at a distance of 60 mm. A notch of 1 mm in length and 0.5 mm in depth in the HAZ of a welded seam in ferritic base material (same type of weld material) is detected by this transducer applying through-transmission of the welded seam with a signal-to-noise ratio of 13 dB. The reflection and transmission of SH waves at the interface between welded cladding and base material has been calculated and experimentally verified. (orig./DG).

20097 (KURRI-TR–322) **Miniature specimen tensile testing technique for neutron irradiated materials.** Miyata, Kiyomi; Yoshida, Hiroyuki. Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst. Aug 1989. 46p. (In Japanese). Order Number DE90749895. Available from NTIS (US Sales Only), PC A03/MF A01.

A miniature tensile testing method has been developed to study effect of neutron irradiation on mechanical properties of the fusion reactor materials. The miniature specimens of pure metals (Fe, Nb, Mo, Ti), SUS316 austenitic steel (JPCA), ferritic-martensitic steel (JFMS) and high manganese steels (A-T, B-T) were used for this miniature tensile testing. The specimens were irradiated using KUR up to a dose of 3.9×10^{16}, 2.6×10^{19} n/cm^2 (E>0.1MeV) at 25K and 360K, respectively. Tensile properties of the specimen was measured at 4.2K, 77K, 170K, 293K and 473K using the tensile test machine of miniature-size specimens (plate: 1.2x5.0,0.1-0.5t, bar: 1.5phix2). It was found that stress-strain curves show characteristics of mechanical properties and temperature dependence of tensile strength, yield strength and fracture strain of the materials, and that neutron irradiation effects on tensile properties can be detected by this method. This system can be successfully applied for tensions up to 5kN in the temperature range from 4.2K to 473K. (author).

20098 (PB–90-854928/XAB) **Tribology: Bearings. January 1970-November 1989 (Citations from the COMPENDEX data base). Report for January 1970-November 1989.** National Technical Information Service, Springfield, VA (USA). Dec 1989. 66p. Available from NTISPC N01/MF N01.

Supersedes PB–89-853972.

This bibliography contains citations concerning design, evaluation, selection, characterization, and failure analysis of the tribology of bearings. Metallic as well as non-metallic bearing materials are considered relative to the applications, type of wear, and thermal environments. Analysis of bearing tribology by laboratory tests and mathematical models is discussed. (This updated bibliography contains 145 citations, 14 of which are new entries to the previous edition.)

20099 (SAND–89-2867C) **Sandia National Laboratories' new high level acoustic test facility.** Rogers, J.D.; Hendrick, D.M. Sandia National Labs., Albuquerque, NM (USA). [1989]. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900479–1: 36. Institute of Environmental Science annual technology meeting, New Orleans, LA (USA), 23-27 Apr 1990). Order Number DE90006810. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A high intensity acoustic test facility has been designed and is under construction at Sandia National Laboratories in Albuquerque, NM. The chamber is designed to provide an acoustic environment of 154dB (re 20 μPa) overall sound pressure level over the bandwidth of 50 Hz to 10,000 Hz. The chamber has a volume of 16,000 cubic feet with interior dimensions of 21.6 ft x 24.6 ft x 30 ft. The construction of the chamber should be complete by the summer of

1990. This paper discusses the design goals and constraints of the facility. The construction characteristics are discussed in detail, as are the acoustic performance design characteristics. The authors hope that this work will help others in designing acoustic chambers. 12 refs., 6 figs.

20100 (SFB-210/A–42, pp. 163-176) **Wind loads and stresses of reinforced concrete chimneys.** Henseleit, O.; Kessler, H. Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke. Mar 1988. (In German). In *Work and result report of Special Research Area 210 for the years 1985-1987.* Available from Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke. Available from Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke.

Natural measurements are necessary for researching the actual exciting mechanisms and the flow conditions around real structures. In particular, the usually empirically determined parameters and calculations should be checked or improved. The project deals with the following questions: Analysis of the wind load transversely to the mean wind direction depending on wind speed, the turbulence of the incoming flow and the vibration behaviour of the building. Determining the maximum resulting building load, taking into account the quasi-static wind load. Determining the local and integral resistance coefficient. Determining the vertical correlation of the transverse load. (orig./KW).

4210 Combustion Systems

Refer also to citation(s) 19826, 19827, 20050

20101 (CONF-8909303–1) **Experimental evaluation of a high-efficiency surface combustor-heater concept with low pollutant emissions.** Khinkis, M.J.; Kunc, W.; Xiong, Tian-yu. Institute of Gas Technology, Chicago, IL (USA). [1989]. 22p. Sponsored by Institute of Gas Technology. CONTRACT GRI-5082-241-0772. From 1989 American Flame Research Committee international symposium on combustion in industrial furnaces and boilers; Short Hills, NJ (USA); 25-27 Sep 1989. Available from OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616.

In a surface combustor-heater being developed by the Institute of Gas Technology (IGT), heat-exchange surfaces are embedded in a stationary bed (porous matrix) of refractory material where gaseous fuel is burned. The overall heat-transfer rate from the combustion products to the embedded heat-exchange surfaces can be significantly enhanced. Also, by removing heat simultaneously with the combustion process, NO_x formation can be significantly reduced. To prove this concept, the bench-scale surface combustor-heater has been tested. Preliminary experimental results are discussed. 3 refs., 10 figs.

20102 (DOE/ER/13553–T3) **On the motion of the center of mass of a spherical turbulent premixed flame.** Cheng, W.K.; Hainsworth, E. Massachusetts Inst. of Tech., Cambridge, MA (USA). [1988]. 23p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-83ER13038;FG02-86ER13553. Order Number DE90006315. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The movement of the center of mass of a premixed statistically spherical flame in the wrinkled-laminar flame regime has been examined. When the flame is small (or comparable) to the integral scale of the turbulence, the flame ball is convected as a whole by the turbulent eddy. When the flame grows to a size large compared to the integral scale, the flame center of motion is not affected by the turbulence. This phenomenon has been explained in terms of the phase coherence of the local turbulent convection velocity at the flame front. When the flame is small, the turbulent velocity is coherent over the entire flame surface; as a result, the flame is convected as a whole by the turbulent eddy. When the flame is large, the velocity at the different area elements of the flame front is independent of each other. The center of mass velocity, which is an aggregate of the velocities at the different elements, therefore, tends to the mean velocity and is independent of the turbulence. A theory for predicting the variance of the flame center velocity has been developed. The prediction is in good agreement with the experimental results. 12 refs., 5 figs.

20103 The absorption of gaseous iodine by water droplets. Albert, M.F. (Tennessee Univ., Knoxville, TN (USA)); Watson, J.S.; Wichner, R.P. *Nuclear Technology (USA),* 77(2): 161-174 (May 1987). DOE Contract AC05-84OR21400.

The authors discuss a new model developed for predicting the rate at which gaseous molecular iodine is absorbed by water sprays. This model is a quasi-steady-state mass transfer model that includes iodine hydrolysis reactions. Results from the model were compared with the results available from the Containment Systems Experiments carried out at Pacific Northwest Laboratory in 1970. The difference between results predicted by the model and the experimental data ranges from -120.5 to 68.0%. The new spray model was also compared to previous spray models. At high concentrations of molecular iodine in the gas, the new spray model is less accurate than an earlier model in predicting available data; however, the new model is believed to be more reliable for extrapolation. At low concentrations, the new model predicts results that are closer to the experimental data than earlier models. The principal advantage of the new model is its potential ability to account for iodine hydrolysis reactions and changes that occur in iodine removal rates as high concentrations of iodine accumulate in the water. Inclusion of the iodine hydrolysis reactions is shown to be important for determining the rate of molecular iodine removal over a wide range of conditions.

20104 Dispensing particles under atmospheric and vacuum conditions using an electrostatic device. Olansen, J.B. (Department of Aerospace & Mechanical Engineering, University of Notre Dame, Notre Dame, Indiana 46556 (USA)); Dunn, P.F.; Novick, V.J. *Journal of Applied Physics (USA),* 66(12): 6098-6109 (15 Dec 1989). 62622401.

Experiments were conducted to determine the operational characteristics of an electrostatic device that dispenses micrometer-size particles continuously without the use of a carrier gas. The dispenser's operational performance was determined under different operating conditions based upon four independent experimental variables: the environmental pressure in which the dispenser was operated, its interelectrode spacing, the applied voltage, and the type of particle used. Measurements were made of the dispenser's operating current and voltage, particle mass dispensing efficiency, and dispensed particle mass flow rate, current, and velocity. An increase in the strength of the dispenser's internal electric field was found to produce an increase in operating current and dispensed particle velocity, current, and mass flow rate. The measured average charge acquired by a particle and the particle average velocity under vacuum conditions were predicted using single particle theory. All temporal measurements of the dispensed particle mass were correlated nondimensionally, independent of the particle type, interelectrode spacing, and applied voltage. The dispensing efficiency under atmospheric conditions, when expressed as a function of the strength of the internal electric field above the minimum field required for particle levitation against gravity, was shown to be independent of particle type.

4220 Mining and Underground Engineering

20105 (LU/CMMER–CE-02847, pp. 26) **Compressed air: A viable source of energy in mining operations.** Wilson, J.C. Laurentian Univ., Sudbury, ON (Canada). Centre in Mining and Mineral Exploration Research. 1989. (CONF-8903185–: Energy efficient technologies in the mining and metals industry, Sudbury (Canada), 29 Mar 1989; CE–02847). In *Energy efficient technologies in the mining and metals industry.* Available from PC Memorial University of Newfoundland, Centre for Newfoundland Studies, St. John's, NF, CAN A1B 3Y1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $30.00 CAN; MF $10 CAN.

This paper discusses the ways to enhance the efficiency of the utilization of compressed air as a source of energy in underground mining. Some examples of current usage are drilling, ventilation, explosive placement, rock bolting, pumping, and other applications.

Energy management is discussed from the points of view of the compressor plant, the pipeline, and the end-user equipment. As an example, by increasing the operating pressure of a drill of 6.5 in diameter from 85 psi to 350 psi, the penetration rate in ore was increased by 700%. A formula is recalled, giving the energy of a rock drill as a function of the drilling parameters; according to the formula, air pressure increases performance by the ratio of the pressure involved to the power 1.5. High-pressure air is also more efficient in removing cuttings from the interface. An appended paper provides the results from carefully controlled tests carried on commercial jackleg machines to determine the increases of the penetration rate, the production, and the drilling cost. Unless there is radical change in breaking hard rock, compressed air will continue to be used in mining operations because of its several advantages. Careful attention must be given to the design of the compressor plant and pipeline network, to the monitoring of the pipeline, to the maintenance of the end-using equipment, and to emerging technologies. 4 refs., 1 tab.

20106 (NEI-NO–101, pp. 7) **Flow after cementing - a field and laboratory studies.** Webster, W.W.; Eikerts, J.V. Norsk Petroleumsforening, Oslo (Norway). 1983. (CONF-8310456–: 1. Northern European drilling conference, Kristiansand (Norway), 24-26 Oct 1983). In *First Northern European drilling conference, Kristiansand, Norway, October 24-26, 1983.* Order Number DE90748476. Available from NTIS (US Sales Only), PC A21/MF A01.

Flow after cementing in oil and gas wells was first recognized as problem in the 1960s but its full impact was not realized by the industry until recently. Cement slurry properties, such as density, rheology, fluid loss, gelation and setting time, have been suggested as contributing to flow after cementing. One property of cement slurries that has not been discussed is water separation. An attempt has been made in this paper, based on laboratory tests and field results, to identify the relationship between water separation in a cement slurry and the loss of hydrostatic head of a cement column and to discover the role of designing cement slurries with little water seperation to control and/or prevent flow after cementing. 7 figs. (Author).

20107 (NEI-NO–101, pp. 18) **Field testing to extend reach of directional wells.** Dellinger, T.B.; Gravley, W.; Tolle, G.C.; Sexton, J.H. Norsk Petroleumsforening, Oslo (Norway). 1983. (CONF-8310456–: 1. Northern European drilling conference, Kristiansand (Norway), 24-26 Oct 1983). In *First Northern European drilling conference, Kristiansand, Norway, October 24-26, 1983.* Order Number DE90748476. Available from NTIS (US Sales Only), PC A21/MF A01.

This paper highlights some of the theoretical aspects of extended-reach drilling and also outlines the field testing to prove the feasibility of the technology. The extremely high cost of deepwater drilling and production platforms has become increasingly more important in the economics of reservoir development. In those cases where multiple platforms are required, a reduction in the member of platforms could mean a significant cost savings. Reservoirs developed using extended-reach drilling techniques could possibly reduce the number of platforms needed. There are also cases of shallow reservoirs below deep water in it is not now possible to develop sufficient acreage from a platform to make a profitable venture. There are other cases where reservoirs cannot now be reached below shipping lanes or other surface restrictions. 10 figs., 2 tabs., 12 refs.

20108 (NEI-NO–101, pp. 30) **Gas migration in cementing annulus.** Sabins, F.L. (Sr.Engineer, Halliburton Services, Duncan, OK (USA)). Norsk Petroleumsforening, Oslo (Norway). 1983. (CONF-8310456–: 1. Northern European drilling conference, Kristiansand (Norway), 24-26 Oct 1983). In *First Northern European drilling conference, Kristiansand, Norway, October 24-26, 1983.* Order Number DE90748476. Available from NTIS (US Sales Only), PC A21/MF A01.

The paper discusses the migration of gas in cementing annulus. Gas flow following cementing has hindered the completion of wells for a number of years. Research of this problem has indicated many solutions which have been either partially successful or unsuccessful operations. The results obtained during a fifteen-month field application of the controlled method is summarized. The results of 250 cement jobs performed world-wide are summed up, and specific examples are discussed in detail. 26 figs., 10 tabs.

20109 (NEI-NO–101, pp. 12) **Experience with low toxicity muds in Conocos's North Sea drilling operations.** Hinton, A.J. Norsk Petroleumsforening, Oslo (Norway). 1983. (CONF-8310456–: 1. Northern European drilling conference, Kristiansand (Norway), 24-26 Oct 1983). In *First Northern European drilling conference, Kristiansand, Norway, October 24-26, 1983.* Order Number DE90748476. Available from NTIS (US Sales Only), PC A21/MF A01.

The paper deals with the experiences with the use of low toxicity muds in the North Sea drilling operations. When oil is the continous phase and the emulsified water is sufficiently saline, the clays will not absorb water. The hole walls remain stable and the cuttings do not swell. All the steel is oil wet which reduces hole drag and the chances of bit balling. Salt formations do not dissolve in oil mud. This means that a gauge hole can be drilled which should lead to an even cement sheath around the casing. This reduces the likekihood of casing collapse due to plastic flow of salt bending or crushing poorly cemented casing. Oil muds deposit a thin, slippery filter cake on the hole walls. This means there is low friction between the borehole and the oil wet drill string. This reduces the chance of becoming differentially stuck in permeable zones. This is very important when drilling, and especially coring, deviated holes in depleted reservoirs. Secondary advantages of using oil muds include the use of PDC bits on turbines. The high penetration rate over long bit runs has greatly reduced drilling times in the Northern North Sea. Lighter mud weights can be run compared to saturated salt mud. Many oils have been tested and used in the field. The common features are that they have a lower aromatic content, are more expensive (due to a longer refining process) and are lower in toxicity than diesel. 19 figs., 1 table, 3 refs.

20110 (NEI-NO–101, pp. 20) **Drilling with top head drivers.** Slator, D.T. (Bowen Tools, Inc., Houston, TX (USA)). Norsk Petroleumsforening, Oslo (Norway). 1983. (CONF-8310456–: 1. Northern European drilling conference, Kristiansand (Norway), 24-26 Oct 1983). In *First Northern European drilling conference, Kristiansand, Norway, October 24-26, 1983.* Order Number DE90748476. Available from NTIS (US Sales Only), PC A21/MF A01.

Power swivels and power subs have been used for many years in workover operations. This paper traces the evolution of such top head drives for primary drilling operations, and defines the present state of the art of both the equipment and the advanced drilling techniques which it has made possible. Applications, limitations and economic considerations are reviewed, based upon field experience on jack-up rigs operating in the Arabian Gulf. Current projects for utilizing top head drives on land rigs are also reviewed. Acceptance of the power swivel concept by the drilling industry has been slow; however, it is concluded that in light of the economics which can be realized by drilling multiple wells from a single location and the demonstrated superiority of top head drive techniques in slant hole drilling, such techniques will receive wide acceptance in the future. 3 figs. (Author).

20111 (NEI-NO–101, pp. 22) **Drilling improvements using power swivels.** Boyadjieff, G. (Varco International, Inc., Orange, CA (USA)). Norsk Petroleumsforening, Oslo (Norway). 1983. (CONF-8310456–: 1. Northern European drilling conference, Kristiansand (Norway), 24-26 Oct 1983). In *First Northern European drilling conference, Kristiansand, Norway, October 24-26, 1983.* Order Number DE90748476. Available from NTIS (US Sales Only), PC A21/MF A01.

The paper deals with a new electric power swivel drilling system being developed and successfully placed in operation. The swivel consists of a 1000 HP electric DC traction motor and an innovative pipe-handling system. Two significant improvements attributable to the new system are excellent reliability and very efficient pipe handling. The time to be needed in the drilling of a well can be reduced up to 40% in some cases. 10 figs., 1 tab., 1 ref.

20112 (NEI-NO–101, pp. 22) **Automation of drilling fluid treatment systems.** Minton, R.C. Norsk Petroleumsforening, Oslo

(Norway). 1983. (CONF-8310456–: 1. Northern European drilling conference, Kristiansand (Norway), 24-26 Oct 1983). In *First Northern European drilling conference, Kristiansand, Norway, October 24-26, 1983.* Order Number DE90748476. Available from NTIS (US Sales Only), PC A21/MF A01.

The process of mixing and treating drilling fluid systems has remained essentially unchanged for decades. There is, however, a growing realisation that our present methods are inefficient, labour intensive, wasteful and, in some instances, pose potential health hazards. One fundamental decision that needs to be taken is whether liquids or powders are preferred medium for the chemicals. There is no technical reason why either should predominate, although certain chemicals could not be efficiently supplied in liquid form. Each medium has its advantages and disadvantages although, on balance, liquids are preferred for their greater ease of handling. There are short, medium and long steps that can be taken towards improving the system and this paper seeks to explore each in turn. 4 figs., 10 tabs. (Author).

20113 (NEI-NO–101, pp. 476) **Drill-string design for directional wells.** Dawson, R. (Exxon Production Research Co., Houston, TX (USA)); Corbett, K.T. Norsk Petroleumsforening, Oslo (Norway). 1983. (CONF-8310456–: 1. Northern European drilling conference, Kristiansand (Norway), 24-26 Oct 1983). In *First Northern European drilling conference, Kristiansand, Norway, October 24-26, 1983.* Order Number DE90748476. Available from NTIS (US Sales Only), PC A21/MF A01.

This paper is concerned with predicting the tension and torsion loads on drill strings in directional wells and with adjusting the string design or well plan to provide adequate strength. Drill-string drag is the incremental force that is required to move the pipe up or down in the hole; torque is the moment required to rotate the pipe. Drag forces are usually given relative to the string weight measured with the string roating but not reciprocating. Measured from the roating string weight, the pick-up drag is usually slightly greater than the slack-off drag. The magnitudes of torque and drag are related in any particular well; high drag forced and exessive torque loads normally occur together. There are a number of phenomena wich contribute to torque and drag. Included are tight hole conditions, sloughing hole, keyseats, differential sticking, cuttings build up due to poor hole cleaning and sliding wellbore friction. With the exception of sliding friction, these causes are associated with problem conditions in the wellbore. Conversely, in wells with good hole conditions, the primary source of torque and drag is sliding friction. This paper is only concerned with the torque and drag caused by sliding friction. The cabability to predict frictional loads on drill pipe has two main benefits. First, more complete knowledge of drill-string loading allows use of improved drill-string design techniques. Drill-string components can be chosen using a systematic approach considering the force involved. Second, deep, highly-deviated wells can be planned to minimize torque and drag. Use of torque and drag as a criteria to select the most appropriate well path will help ensure successful drilling operations to total depth. 1 fig., 2 tabs. (Author).

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Refer also to citation(s) 19275, 19776

20114 (NEI-NO–101, pp. 13) **Development and application of low-toxic oil based muds.** Tyldsley, D. (Norsk Hydro, Oslo (Norway)). Norsk Petroleumsforening, Oslo (Norway). 1983. (CONF-8310456–: 1. Northern European drilling conference, Kristiansand (Norway), 24-26 Oct 1983). In *First Northern European drilling conference, Kristiansand, Norway, October 24-26, 1983.* Order Number DE90748476. Available from NTIS (US Sales Only), PC A21/MF A01.

The paper deals with low-toxic oil based muds. The objective is to give a review on the development and summarize the results achieved from the drilling date with these muds. 3 figs., 3 tabs.

20115 (NEI-NO–101, pp. 22) **Application of shear ram for production wells.** Lindland, H.J. (Norske Stats Oljeselskap A.S., Stavanger (Norway)). Norsk Petroleumsforening, Oslo (Norway). 1983. (CONF-8310456–: 1. Northern European drilling conference, Kristiansand (Norway), 24-26 Oct 1983). In *First Northern European drilling conference, Kristiansand, Norway, October 24-26, 1983.* Order Number DE90748476. Available from NTIS (US Sales Only), PC A21/MF A01.

Offshore activities where wells are highly productive and closely spaced have accelerated the search for better and safer methods of protection against blowouts. Two examples of this are subsurface safety valves and fire resistant Xmas trees. This paper deals with a shear ram designed for this purpose. 8 figs.

20116 (SFB-210/A–42, pp. 143-162) **Fatigue behaviour of buildings made of hollow steel sections under flow loads.** Mang, F.; Klingler, J.; Bucak, O. Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke. Mar 1988. (In German). In *Work and result report of Special Research Area 210 for the years 1985-1987.* Available from Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke. Available from Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke.

The aim of these investigations is therefore to find the effects on the fatigue strength behaviour of hollow section designs by systematic experiments with different load systems and to research the applicability of damage accumulation hypotheses. Apart from basic single stage experiments, which act as a basis of comparison, strength experiments should also be carried out with the load spectra characteristic of crane construction and aerial supports. By means of the collective 'Laplace' form and two North Sea collectives, the connectiuon should be made with international Offshore research, the aim of which is the determination of fatigue stresses on sea structures with water flowing round them. (orig./KW).

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Refer also to citation(s) 19487, 19496, 19499, 19571, 19776, 19859, 19869, 19870, 19928, 19936, 19939, 19955, 19984, 20094, 20157, 20173, 20217, 20218, 20226, 20238, 20250, 20252, 20253, 20489, 20640, 20816, 20943, 21007, 21015, 21035, 21044, 21045, 21055, 21058, 21071, 21072

20117 (AD-A–214036/6/XAB) **Near-threshold behavior of multimode continuous-wave dye lasers with amplitude-modulated pump.** Chakmakjian, S.H.; Papademetriou, S.; Koch, K.; Stroud, C.R. Rochester Univ., NY (USA). Inst. of Optics. 15 Aug 1989. 11p. Available from NTIS, PC A03/MF A01.

Pub. in Physical Review A, Vol. 40, No. 4, 1858-1867(15 Aug 1989).

Amplitude-modulation techniques are used to investigate the response of a multimode dye laser when its pump intensity is sinusoidally amplitude-modulated. A theoretical model is presented based on a Floquet analysis to obtain the stationary-state first-harmonic response of the population inversion and that of the laser intensity as a function of modulation frequency. Experiments were performed in multimode continuous-wave dye lasers to demonstrate the validity of this theory in describing the behavior of multimode lasers operating near the lasing threshold.

20118 (AD-A–214063/0/XAB) **Microchannel heat sinks for two-dimensional high-power-density diode laser arrays.** Missaggia, L.J.; Walpole, J.N.; Liau, Z.L.; Phillips, R.J. Massachusetts Inst. of Tech., Lexington, MA (USA). Lincoln Lab. 9 Sep 1989. 7p. (JA–6265). Available from NTIS, PC A02/MF A01.

Pub. in IEEE Jnl. of Quantum Electronics, Vol. 25, No. 9, 1988-1992(Sep 1989).

A two-dimensional GaInAsP/InP diode laser array was operated with CW power dissipation up to 500 W/cc into a Si microchannel heat sink. The approximately 1 x 4 sq mm laser array was used to characterize the heat sink and a value of 0.040 C sq cm/W for the thermal resistance per unit area was deduced. The extrapolated value for a 1 sq cm heated area is 0.070 C sq cm/W.

20119 (AD-A–214064/8/XAB) **End-pumped Nd:LaF3 and Nd:LaMgAl(11)O(19) lasers.** Fan, T.Y.; Kokta, M.R. Massachusetts Inst. of Tech., Lexington, MA (USA). Lincoln Lab. Aug 1989. 7p. (JA–6225). Available from NTIS, PC A02/MF A01.

Pub. in IEEE Jnl. of Quantum Electronics, Vol. 25, No. 8, 1845-1849(Aug 1989).

Neodymium:lanthanum fluoride and neodymium/lanthanum magnesium aluminate (LMA) are promising candidates for pulsed diode laser-pumped lasers because they have relatively long upper-state lifetimes and large absorption bandwidths compared to other Nd(3+) doped materials. Crystal growth of LMA and spectroscopic properties of these materials are described. Continuous-wave end-pumped lasers have been demonstrated in these materials using a $Ti:Al_2O_3$ as the pump source to simulate a diode laser. Slope efficiencies of 47% for Nd:LaF3 and 32% for Nd:LMA were obtained. The results for Nd:LaF3 are typical for end-pumped, CW, Nd(3+) lasers; the lower slope efficiency for Nd:LMA is attributed to excited-state absorption.

20120 (AD-A-214146/3/XAB) **Development of glass-ceramic lasers. Final report, 1 February 1986-31 May 1989.** Lempicki, A.; Keyes, T.; Wojtowicz, A.J.; Kazmierczak, M.; Chen, J.J. Boston Univ., MA (USA). Dept. of Chemistry. Aug 1989. 195p. Available from NTIS, PC A09/MF A02.

The goal of this program was to ascertain the possibility of developing a Tunable Solid State Laser, based on Cr-doped transparent glass ceramics. To this end the spectroscopy of Cr in mullite ceramics and related aluminosilicate crystals was studied in detail. The results indicate an extremely large inhomogenous broadening, interpreted in terms of a statistical distribution of crystal fields. The main limitation of these materials is the high scattering loss which should be reduced by at least a factor of 10, before laser applications are contemplated. Work on scattering led to the discovery of un-averaged, angularly distributed intensity fluctuations in amorphous materials. This work was carried out on CVD silica as well as on ceramics and led to new insights concerning the statistics of speckle phenomena.

20121 (AD-A-214151/3/XAB) **Linewidth and offset-frequency locking of external-cavity GaAlAs lasers.** Harrison, J.; Mooradian, A. Massachusetts Inst. of Tech., Lexington, MA (USA). Lincoln Lab. Jun 1989. 6p. (JA-6202). Available from NTIS, PC A02/MF A01.

Pub. in IEEE Jnl. of Quantum Electronics, Vol. 25, No. 6, 1152-1155(Jun 1989).

Two ultrastable external-cavity GaAlAs diode lasers were locked together with a resolution of better than 10 Hz.

20122 (AD-A-214155/4/XAB) **Scalable, end-pumped, diode-laser-pumped laser.** Fan, T.Y.; Sanchez-Rubio, A.; DeFeo, W.E. Massachusetts Inst. of Tech., Lexington, MA (USA). Lincoln Lab. 1 Oct 1989. 4p. (JA-6308). Available from NTIS, PC A01/MF A01.

Pub. in Optics Letters, Vol. 14, No. 19, 1057-1059(1 Oct 1989).

A novel technique for scaling end-pumped lasers is demonstrated using three diode-laser arrays to pump a single Nd:YAG laser. Diffraction-limited output with a 58% slope efficiency was obtained. Simple arguments indicate that this method should allow at least an order-of-magnitude increase in pump power, compared with that from a single high-power diode array, to be focused into the same fixed-mode volume of the pumped laser. Such a scheme may be particularly useful with low-gain, quasi-three-level, or tunable lasers.

20123 (AD-A-214217/2/XAB) **Additive-pulse mode locking.** Ippen, E.P.; Haus, H.A.; Liu, L.Y. Massachusetts Inst. of Tech., Cambridge, MA (USA). Research Lab. of Electronics. 1989. 11p. Available from NTIS, PC A03/MF A01.

Pub. in Jnl. of the Optical Society of America B, 1736-1745(1989).

A new principle of mode locking is analyzed: additive-pulse mode locking. It is shown to be operative in two-cavity soliton lasers, but it also permits mode locking with fibers in the positive dispersion regime. A simple model is developed that displays the pulse-shortening mechanism. Parameter ranges, within which this principle can be exploited, are given. Comparisons with experiments are made.

20124 (AD-A-214285/9/XAB) **Gas optics applicable to free-electron laser-technology. Final technical report, 15 December 1983-31 May 1989.** Christiansen, W.H. Washington Univ., Seattle, WA (USA). Aerospace and Energetics Research Program. 23 Oct 1989. 28p. Available from NTIS, PC A03/MF A01.

The free-electron laser has the potential of being a highly efficient short-wavelength laser. The designs of these lasers are hampered by excessively long optical cavities required by practical considerations of the mirror reflectors. A solution to this problem may be the use of defocusing gas optics in conjunction with the traditional mirror optics. Estimates show that the length of the optical cavity may be reduced by over an order of magnitude with this approach. A program of experimental and theoretical research was carried out to study the various aspects of gas optics for use with the free-electron laser.

20125 (AD-A-214407/9/XAB) **Research on a millimeter wavelength free-electron laser. Annual technical summary and status report, October 1988-September 1989.** Marshall, T.C. Columbia Univ., New York, NY (USA). Nevis Labs. Sep 1989. 27p. Available from NTIS, PC A03/MF A01.

Availability: Document partially illegible.

The author found evidence for optical guiding as it occurs in has system (2mm Raman FEL in an overmoded waveguide) in the regime of exponential growth, using first, a study of the guided-field profile, and secondly, a study of the sideband spectrum. He has not yet found firm evidence for optical guiding as it may occur under conditions of signal saturation or slow growth along a tapered undulator, however. This negative result is probably caused by experimental conditions peculiar to the apparatus and techniques, and would not apply to the short-wavelength FEL case of an electron beam in nearly empty space. The theoretical study is able to model the results obtained quantitatively in the linear regime, and it has permitted him to understand why he has not been able to observe guiding at signal-saturation conditions in the present apparatus. The same model that successfully interprets the guiding experiments in the linear regime would predict acceptable optical guiding in his system if the latter did not incorporate a waveguide wall, and if he were able to initiate signal growth with a strong coherent source of power (rather than using noise as the source).

20126 (DOE/ER/30131-T9) **Assessment of research needs for laser technologies applied to advanced spectroscopic methods: Final report.** Hurst, G.S. Consultec Scientific, Inc., Knoxville, TN (USA). Jan 1990. 73p. Sponsored by U.S. DOE Energy Research. DOE Contract AC01-88ER30131. Order Number DE90007402. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The Department of Energy (DOE) recognizes that new developments in laser technology and laser spectroscopy can substantially improve the ability to carry out the mission of its Office of Health and Environmental Research (OHER). In brief, the mission of OHER is to support programs of research which allow DOE to understand and anticipate long term effects upon human health and the environment from the production and utilization of alternate forms of energy, and to apply the department's unique capabilities to solve numerous problems in biology and medicine. A DOE study was managed by Consultec Scientific, Inc. who furnished from its staff the Principal Investigator who, in turn, coordinated the enthusiastic efforts of a group of consultants consisting of some of the world's best scientists in the world. The panel made six specific recommendations which dealt with three important areas. First the panel recommends that OHER closely monitor and be prepared to use the advances now being made in solid-state laser technology. These advances, comparable in nature to the revolution which began during the 1950's in solid-state electronics, will radically improve present-day laser technology. Secondly, the panel addressed the use of this advanced technology to maintain the preeminent position which OHER has already created for itself in the development of selective and sensitive instruments for the analysis of atomic and molecular substances and to extend the use of these to measure chemical pollutants in air, soil, and water. Finally, another area of the recommendations dealt with the use of lasers to determine structural and dynamical features of macromolecules and especially to develop x-ray lasers and other imaging techniques, including holographic ones, for sequencing DNA and the human genome. 208 refs., 2 figs., 2 tabs.

20127 (LA-UR–89-669) **Time resolved gain/loss studies under low and high power loading for the XeF C-A transition.** Sze, R.C. (Los Alamos National Lab., NM (USA)); Sentis, M.; Vannini, M. Los Alamos National Lab., NM (USA). [1990]. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-900368–2: International conference on optical science and engineering, Hague (Netherlands), 12-16 Mar 1990). Order Number DE90007506. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The behavior of gain versus peak power deposition and the gain-length product versus total energy deposited are measured for devices with power deposition levels from 1 to 13 MW/cm^3 under a variety of gas mixtures. The temporal correlation between the power deposition and gain shows that both the fluorescence and the gain occur after the power deposition has concluded for excitation pulses in the range of 10–30 ns. We find that both B-X and C-A fluorescence takes place in the afterglow and their temporal shapes are similar. This indicates that the C and B states are tightly coupled. This tight coupling has two detrimental consequences for C-state lasing. First is that the population of the B and C states are approximately equal rather than 90% in the C state believed to exist for short pulse electron beam excitation. We believe this close coupling is due to the presence of electric fields in the afterglow which keep the electron temperature relatively hot. The relative populations of the B and C states are determined by a Boltzman distribution governed by the electron temperature and their relative energy separation. Second is that with the C state lifetime approximately the same as the B state lifetime the C-A saturation intensity is very high and efficient energy extraction is substantially more difficult. 5 refs., 10 figs.

20128 (LA-UR–90-161) **Blue upconversion thulium laser.** Nguyen, D.C.; Faulkner, G.E.; Weber, M.E.; Dulick, M. Los Alamos National Lab., NM (USA). 1990. 10p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-900162–2: Technical symposium on laser spectroscopy, Los Angeles, CA (USA), 14-19 Jan 1990). Order Number DE90006517. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Upconversion has been an active area of research for at least two decades, mainly because of its wide ranging applications from infrared quantum counters, visible-emitting phosphors, to upconversion lasers. The upconversion lasers have recently become attractive with the advent of semiconductor laser diodes as the pump source. In an upconversion laser, the laser active ion is excited by internal upconversion of near-ir or red light via multiphoton excitation or cooperative processes and emits anti-Stokes visible light. Since the laser diode output wavelength can be composition turned to match the upconversion laser ion absorption lines, a substantial fraction of the ions can be driven into higher energy levels, thus enhancing the upconversion process. These upconversion solid-state lasers offer a potentially simple and compact source of visible coherent light with semiconductor laser diode excitation. We recently reported a novel upconversion thulium laser that emits blue light at 77 K. In this paper additional data on this 77 K upconversion laser as well as preliminary results on the room temperature upconversion laser are presented. In these demonstrations, dye lasers were used instead of diode lasers because they were more readily available than high power semiconductor laser diodes and their wavelengths could be adjusted easily. 14 refs., 5 figs., 1 tab.

20129 (LA-UR–90-496) **Laser-matter interaction at intensities of 10^{12} W/cm^2 and below.** Goldman, S.R.; Dingus, R.S.; Kirkpatrick, R.C.; Kopp, R.A.; Stover, E.K.; Watt, R.G. Los Alamos National Lab., NM (USA). [1990]. 9p. Sponsored by U.S. Department of Defense; U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-900368–1: International conference on optical science and engineering, Hague (Netherlands), 12-16 Mar 1990). Order Number DE90007536. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

For single pulsed laser-matter interactions at sufficiently high intensity, the electron density in the ablated vapor is large enough to absorb the laser radiation before it can reach the dense target material. The resulting interaction can be described in terms of energy flows: laser energy is absorbed in the plasma in front of the target and reappears as thermal electron energy and secondary radiation, part of which impinges upon and heats the dense target material at the dense material-vapor interface. This heating in turn drives ablation, thereby providing a self-consistent mass source for the laser absorption, energy conversion, and transmission. Under typical conditions of laser intensity, pulse width and spot size, the flow patterns can be strongly two-dimensional. We have modified the inertial confinement fusion code LASNEX to simulate gaseous and some dense material aspects for the relatively low intensity, long-pulse-length conditions to interest in many laser-related applications. The unique aspect to our treatment consists of an ablation model which defines a dense material vapor interface and then calculates the mass flow across this interface. The model, at present, treats the dense material as a rigid, two-dimensional simulational mass and heat reservoir, suppressing all hydrodynamical motion in the dense material. The modeling is being developed and refined through simulation of experiments, as well as through the investigation of internal inconsistencies, and some simulations of model problems. 5 refs., 14 figs., 1 tab.

20130 (LA-UR–90-655) **Anode plasma formation as a possible mechanism for an electrical stress limit in cold cathode diodes.** Rosocha, L.A. Los Alamos National Lab., NM (USA). [1990]. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-8906200–4: Large area electron beam diode workshop, Monterey, CA (USA), 7 Jun 1989). Order Number DE90007503. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Recent interest in scaling electron-beam pumped KrF fusion lasers to the energy levels thought necessary for ignition (MJ-class) has stimulated the development of technology related to broad-area electron beam generators. At this conference, McGeoch has proposed, based upon an examination of widespread electron-beam pumped KrF laser data, that a fundamental limit for electrical stress within the electron gun diode exists. McGeoch and others have attributed the mechanism for the limit to gas evolution at the anode due to heating by the e-beam, and a consequent breakdown in the diode due to this gas. 4 refs., 2 figs.

20131 (LA-UR–90-696) **First direct observation of FEL [free-electron laser] lasing from λ = 20 to 45μm.** Lumpkin, A.H.; Feldman, D.W.; Solid, J.E.; Warren, R.W.; Stein, W.E.; Johnson, W.J.; Watson, J.M.; Newnam, B.E.; Goldstein, J.C. Los Alamos National Lab., NM (USA). [1989]. 14p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-8908134–30: 11. international free electron laser conference, Naples, FL (USA), 28 Aug - 1 sep 1989). Order Number DE90007508. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In recent experiments at Los Alamos, we directly observed for the first time free-electron laser (FEL) fundamental wavelengths from 20 to 45μm. Our 1988 facility's demonstrated wavelength span now extends from 9 to 45μm. Upgrades are in progress to increase this span. This wavelength region uniquely complements existing FEL applications facilities. 5 refs., 6 figs., 1 tab.

20132 (ORNL/TM–11428) **Maintenance Management Department annual work plan FY 1990–1992.** Keller, D.N. Oak Ridge National Lab., TN (USA). 15 Oct 1989. 15p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC05-84OR21400. Order Number DE90005822. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Instrumentation and Controls Division's Maintenance Management Department (MMD) provides maintenance services in the areas of fabrication, modification, installation, calibration, operation, repair, and preventive maintenance of instruments and other related equipment. The MMD annual work plan is dependent on the programmatic activities of the laboratory. As laboratory funding allocations and priorities change, the activities of the department must also adapt to provide flexible programmatic support as needed. 2 figs., 2 tabs.

20133 (PB–90-138512/XAB) **National Action Plan on superconductivity research and development. Background report.** Executive Office of the President, Washington, DC (USA). Dec 1989. 79p. Available from NTIS, PC A05/MF A01.

This document presents the Superconductivity Action Plan pursuant to the Superconductivity and Competitiveness Act of 1988. Development of the Plan was coordinated by the Office of Science and Technology Policy (OSTP) with consultation from tthe staff of the National Critical Materials Council (NCMC). The Plan draws upon contributions from leaders in the technical community of the Federal Government responsible for superconductivity research and development programs, as well as from the report of the Committee to Advise the President on Superconductivity. Input from leaders in the private sector was obtained during the formulation and review of the Plan. Contents: Coordination of the Plan (Annual Reports and Ongoing Analysis of Funding); Technical areas (High-Temperature Superconductivity Materials in General, High-Temperature Superconductivity Films for Sensors and Electronics, Magnets, Large-Area High Temperature Superconductivity Films, Bulk Conductors, Materials Production and Processing Technology, Materials and Coolant Supply); Policy Areas (Research and Experimentation Tax Credit, Capital Gains Tax Differential, International Cooperation, Science and Technology Base, Environment, Health, and Safety).

20134 (PB–90-855537/XAB) **Ultraviolet lasers. January 1970-October 1983 (Citations from the COMPENDEX data base). Report for January 1970-October 1983.** National Technical Information Service, Springfield, VA (USA). Dec 1989. 92p. Available from NTISPC N01/MF N01.

See also PB–90-855545.

This bibliography contains citations concerning repetitive, tunable, high-power vacuum-ultraviolet lasers. Special application coatings and methods of efficient generation for ultraviolet lasers, long-pulse ultraviolet-laser emissions, spectral characteristics of vacuum-ultraviolet preionization sources for CO_2 lasers, and experimental investigations of aero-acoustic effects in large-volume ultraviolet-laser discharges are discussed. Ultraviolet-laser performance evaluations and spectroscopy are included. (This updated bibliography contains 144 citations, none of which are new entries to the previous edition.)

20135 (PB–90-855545/XAB) **Ultraviolet lasers. November 1983-November 1989 (Citations from the COMPENDEX data base). Report for November 1983-November 1989.** National Technical Information Service, Springfield, VA (USA). Dec 1989. 131p. Available from NTISPC N01/MF N01.

Supersedes PB–84-851559. See also PB–90-855537.

This bibliography contains citations concerning repetitive, tunable, high-power vacuum ultraviolet lasers. Special application coatings and methods of efficient generation for ultraviolet lasers, long-pulse ultraviolet-laser emissions, spectral characteristics of vacuum ultraviolet preionization sources for CO_2 lasers, and experimental investigations of aero-acoustic effects in large-volume ultraviolet-laser discharges are discussed. Ultraviolet-laser performance evaluations and spectroscopy are included. (This updated bibliography contains 282 citations, all of which are new entries to the previous edition.)

20136 (SAND–89-2959C) **Novel processing of HTS based conductors.** Ginley, D.S. (Sandia National Labs., Albuquerque, NM (USA)); Venturini, E.L.; Kwak, J.F.; Baughman, R.J.; Bourcier, R.J.; Mitchell, M.A.; Morosin, B.; Halloran, J.W.; Neal, M.J.; Capone, D.W. Sandia National Labs., Albuquerque, NM (USA). [1990]. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900466–1: Spring meeting of the Materials Research Society, San Francisco, CA (USA), 16-21 Apr 1990). Order Number DE90005956. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Conductor development is one of the major long term goals in high temperature superconductor research. In this paper we report on two promising processing technologies that have been utilized to produce superconducting HTS conductors. First, melt spun $YBa_2Cu_3O_7$ fibers rapid thermal processed for 1–8 sec at 950 to 1075°C have T_c's to 92 K, J_c's to 1100 A/cm^2 and the orthorhombic twinned morphology typical for high quality $YBa_2Cu_3O_7$. A processing matrix of time, temperature and composition for these fibers shows that slightly CuO-rich starting compositions give the best results. Second, silver tube encapsulated wires of $Bi_{1.7}Pb_{0.3}Sr_2Ca_2Cu_3O_{10}$ have been made by extrusion, wire drawing and cold rolling. The resulting tapes show orientation of the crystallites, zero resistance up to 100K and improved magnetic hysteresis above 50 K. The combination of mechanical reprocessing and extended thermal anneals near 850°C appears to significantly improve these materials. 13 refs., 7 figs.

20137 (SAND–89-8266) **DANCIR [Device and Circuit Simulator]: A three-dimensional steady-state semiconductor device simulator.** Meza, J.C.; Grear, J.F. Sandia National Labs., Livermore, CA (USA). Jan 1990. 28p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC04-76DP00789. Order Number DE90006370. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report discusses a program called DANCIR that was developed to model semiconductor devices. DANCIR, which stands for Device and Circuit Simulator, enables the user to computer the steady-state solution to the drift-diffusion equations for a single semiconductor device. The drift-diffusion equations that describe carrier motion in a semiconductor device can be used to compute operating characteristics for a semiconductor device. This allows the engineer to design different devices and predict the behavior of these devices without resorting to the time-consuming process of building many prototypes. 22 refs., 4 figs.

20138 (SAND–90-0277C) **Coating possibilities for magnetic switches.** Sharp, D.J.; Harjes, H.C.; Mann, G.A.; Morgan, F.A. Sandia National Labs., Albuquerque, NM (USA). [1990]. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900280–1: International workshop on magnetic pulse compression, Lake Tahoe, NV (USA), 12-14 Feb 1990). Order Number DE90006536. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

High average power magnetic pulse compression systems are now being considered for use in several applications such as the High Power Radiation Source (HiPoRS) project. Such systems will require high reliability magnetic switches (saturable inductors) that are very efficient and have long lifetimes. One of the weakest components in magnetic switches is their interlaminar insulation. Considerations related to dielectric breakdown, thermal management of compact designs, and economical approaches for achieving these needs must be addressed. Various dielectric insulation and coating materials have been applied to Metglas foil in an attempt to solve the complex technical and practical problems associated with large magnetic switch structures. This work reports various needs, studies, results, and proposals in selecting and evaluating continuous coating approaches for magnetic foil. Techniques such as electrophoretic polymer deposition and surface chemical oxidation are discussed. We also propose continuous photofabrication processes for applying dielectric ribs or spacers to the foil which permit circulation of dielectric liquids for cooling during repetitive operation. 10 refs., 8 figs., 11 tabs.

20139 (UCRL–52000-89-12) **Energy and Technology Review, December 1989.** Burnham, A.K.; de Vore, L.; Gleason, K.; Sanford, N.M.; Taft, S.O. (eds.). Lawrence Livermore National Lab., CA (USA). 1989. 54p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008107. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This "Energy and Technology Review" contains topics related to applications of x-ray optics, both current and projected. (JEF)

20140 (UCRL–101650) **A ground state depleted laser in neodymium doped yttrium orthosilicate.** Beach, R. (Lawrence Livermore National Lab., CA (USA)); Albrecht, G.; Solarz, R.; Krupke, W.; Comaskey, B.; Mitchell, S.; Brandle, C.; Berkstresser, G. Lawrence Livermore National Lab., CA (USA). 16 Jan 1990. 23p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900140–11: SPIE optics, electro-optics and laser applications in science and engineering conference and exhibition, Los Angeles, CA (USA), 20-25 Jan 1990). Order Number DE90006773. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A ground state depleted $(GSD)^{1,2}$ laser has been demonstrated in the form of a Q-switched oscillator operating at 912 nm. Using Nd^{3+} as the active ion and Y_2SiO_5 as the host material, the laser

transition is from the lowest lying stark level of the $Nd^{3+}F_{3/2}$ level to a stark level 355 cm^{-1} above the lowest lying one in the $^4I_{9/2}$ manifold. The necessity of depleting the ground $^4I_{9/2}$ manifold is evident for this level scheme as transparency requires a 10% inversion. To achieve the high excitation levels required for the efficient operation of this laser, bleach wave pumping using an alexandrite laser at 745 nm has been employed. The existence of a large absorption feature at 810 nm also allows for the possibility of AlGaAs laser diode pumping. Using $KNbO_3$, noncritical phase matching is possible at 140°C using d_{32} and has been demonstrated. The results of Q-switched laser performance and harmonic generation in $KNbO_3$ will be presented. Orthosilicate can be grown in large boules of excellent optical quality using a Czochralski technique. Because of the relatively small 912 nm emission cross section of 2-3 x 10^{-20} cm^2 (orientation dependent) fluences of 10-20 J/cm^2 must be circulated in the laser cavity for the efficient extraction of stored energy. This necessitates very aggressive laser damage thresholds. Results from the Reptile laser damage facility at Lawrence Livermore National Laboratory (LLNL) will be presented showing Y_2SiO_5 bulk and AR sol-gel coated surface damage thresholds of greater than 40 J/cm^2 for 10 nsec, 10 Hz, 1.06 μ pulses. 16 refs., 18 figs., 6 tabs.

20141 (UCRL–101720) **Properties and performance of the $LiCaAlF_6:Cr^{3+}$ laser material.** Payne, S.A.; Chase, L.L.; Atherton, L.J.; Caird, J.A.; Kway, W.L.; Shinn, M.D.; Hughes, R.S.; Smith, L.K. Lawrence Livermore National Lab., CA (USA). Jan 1990. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900140–8: SPIE optics, electro-optics and laser applications in science and engineering conference and exhibition, Los Angeles, CA (USA), 20-25 Jan 1990). Order Number DE90007242. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The laser properties of the $LiCaAlF_6:Cr^{3+}$ (Cr:LiCAF) material are reviewed. The impact of the absorption and emission spectra on the laser performance is discussed. Laser-pumping and flashlamp-pumping experiments have shown that Cr:LiCAF has potential for high efficiency, although the presence of scattering losses remains a significant problem. The "gradient freeze" growth technique has been found to generate lower-loss material compared to Czochralski growth. The thermal lensing of Cr:LiCAF has been measured to be small and is in rough agreement with the magnitude expected on the basis of the intrinsic thermo-optical properties. 16 refs., 5 figs., 2 tabs.

20142 (UCRL–102757) **Field effect transistor structures based on strain induced polarization charges.** Smith, D.L. (Los Alamos National Lab., NM (USA)); Collins, R.T.; Kuech, T.F.; Mailhoit, C. Lawrence Livermore National Lab., CA (USA). Dec 1989. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-891119–96: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989). Order Number DE90007247. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We suggest a new field effect transistor based on strain-induced polarization charges. The structure utilizes the pseudomorphic growth of a strained barrier layer on a substrate oriented in a polar direction such as [111] or [211]. Polarization charges in the barrier layer are generated by the piezoelectric effect. A two-dimensional (2-D) electron gas, whose density can be modulated by an external bias, forms at the hetero-interface and it screens the polarization charge. Zero bias densities of several 10^{11} e/cm^2 and threshold voltages of 0.5 V can be achieved. Both normally-on and normally-off structures are possible. 14 refs., 3 figs.

20143 **Materials for high average power lasers.** Marion, J.E. (Univ. of California, Lawrence Livermore National Lab., Livermore, CA (US)); Pertica, A.J. pp. 203 of High power and solid state lasers II. Dubie, G SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (1989). DOE Contract W-7405-ENG-48. (CONF-890157–: 2. conference on high power and solid state lasers, Los Angeles, CA (USA), 19-20 Jan 1989).

Unique materials properties requirements for solid state high average power (HAP) lasers dictate a materials development research program. A review of the desirable laser, optical and thermo-mechanical properties for HAP lasers is presented. An assessment of the development status for crystalline and glass hosts optimized for HAP lasers is made.

20144 **Ground state depleted (GSD) solid state lasers: Principles, characteristics, and scaling.** . Krupke, W.F. (Lawrence Livermore National Lab., Livermore, CA (US)); Chase, L.L. pp. 203 of High power and solid state lasers II. Dubie, G SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (1989). DOE Contract W-7405-ENG-48. (CONF-890157–: 2. conference on high power and solid state lasers, Los Angeles, CA (USA), 19-20 Jan 1989).

A novel class of rare earth doped solid state lasers is described. The ground state depleted (GSD) laser is pumped by an intense narrowband laser source and is characterized by: an unusually low laser ion doping density, an unusually large fractional excited population inversion density, a gain element that is optically thick at the pump wavelength, and a gain element that has a substantially uniform gain distribution due to a bleaching of the pump transition at the pump intensity utilized. These features enable efficient room temperature operation of rare earth ion laser transitions terminating on the ground manifold. The relationships between laser parameters cross sections, saturation fluences and fluxes, bleaching wave velocities, etc.) are given and laser performance scaling relationships are presented and discussed.

20145 **Ground state depleted laser experiments.** Beach, R. (Lawrence Livermore National Lab., Livermore, CA (US)); Solarz, R.; Mitchell, S.; Brewer, L.; Weinzapfel, S. pp. 203 of High power and solid state lasers II. Dubie, G SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (1989). (CONF-890157–: 2. conference on high power and solid state lasers, Los Angeles, CA (USA), 19-20 Jan 1989).

The authors describe testing done on ground state depleted (GSD) lasers. They are room temperature, four-level, high energy density lasers with uniform gain when pumped either transversely or longitudinally. Results of the experiments are presented and discussed.

20146 **Q-switched, intracavity doubled Nd:YAG laser side-pumped by a laser diode array.** Bass, I.L. (Lawrence Livermore National Lab., Livermore, CA (US)); Presta, R.W. pp. 203 of High power and solid state lasers II. Dubie, G SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (1989). DOE Contract W-7405-ENG-48. (CONF-890157–: 2. conference on high power and solid state lasers, Los Angeles, CA (USA), 19-20 Jan 1989).

An intracavity-doubled, Q-switched, Nd:YAG laser side pumped by a pulsed, 3-bar, laser-diode array, produced a second harmonic output of 1.75 mJ/pulse at an optical conversion efficiency of 11.5%. The authors demonstrate the use of this laser to pump a pulsed dye laser via an optical fiber.

20147 **Ultrahigh-brightness XeCl laser system.** Gibson, R.B. (Los Alamos National Lab., Los Alamos, NM (US)); Gosnell, T.R.; Lester, C.S.; Roberts, J.P.; Tallman, C.R.; Taylor, A.J. pp. 203 of High power and solid state lasers II. Dubie, G SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (1989). (CONF-890157–: 2. conference on high power and solid state lasers, Los Angeles, CA (USA), 19-20 Jan 1989).

The authors discuss the development of a laser system that produces terawatt-level pulses of 308-nm light with near-diffraction-limited beam quality. Pulses of 175-fs duration are generated at 616 nm in a synchronously-pumped mode-locked dye oscillator. These pulses are amplified in a three-stage dye amplifier longitudinally pumped by the frequency-doubled out of a regenerative Nd:YAG amplifier. Output of the dye amplifier is frequency-doubled in a BBO crystal and amplified in a chain of XeCl excimer stages. The optical design maintains high beam quality throughout the system.

20148 **Ultra-high brightness laser research at LLNL.** Patterson, F.G. (Lawrence Livermore National Lab., Univ. of California, Livermore, CA (US)); Perry, M.D.; Campbell, E.M. pp. 203 of High power and solid state lasers II. Dubie, G SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (1989). DOE Contract W-7405-ENG-48. (CONF-890157–: 2. conference on high

power and solid state lasers, Los Angeles, CA (USA), 19-20 Jan 1989).

New short-pulse laser technology has made possible the production of extremely bright ($>10^{18}$ W/cm^2-sr) laser sources. The use of these new techniques on large scale Nd:glass based laser systems would make it possible to produce 1000 TW (Petawatt) pulses. Such pulses would yield focused intensities exceeding 10^{21} W/cm^2 corresponding to an electric field in excess of 100 e/a_0^2 and an energy density equivalent to that of a 10 keV blackbody. The first step towards the realization of such a source is the development of a compact 10 TW laser. The design of a 10 TW table-top laser and some potential applications are described.

20149 Performance and operation of the upgraded Nova laser. Kyrazis, D.T. (Lawrence Livermore National Lab., Livermore, CA (US)); Speck, D.R.; Bibeau, C.; Ehrlich, R.B.; Hermes, G.L.; Smith, J.R.; Weiland, T.L.; Wegner, P.J. pp. 203 of High power and solid state lasers II. Dubie, G SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (1989). (CONF-890157–: 2. conference on high power and solid state lasers, Los Angeles, CA (USA), 19-20 Jan 1989).

Over the past year, the Nova laser at the Lawrence Livermore National Laboratory has been undergoing major refurbishment. Concurrently, an extensive research program has been undertaken to characterize and understand, in detail, the characteristics of Nova and the factors which limit its performance. As a result of these combined efforts, Nova now exceeds its original performance goals. Among the topics discussed are the substitution of platinum free laser glass in the power amplifier section of the Nova beamlines; increased frequency conversion efficiency, and large optic damage resulting from transverse stimulated Brillouin scattering. When the authors have implemented the necessary changes on all 10 Nova beamlines, they will be able to routinely deliver 120 kilojoules of energy at 1.053 μm, and 75 kilojoules at 0.351 μm.

20150 OMEGA upgrade staging options. Kelly, J.H. (Lab. for Laser Energetics, Univ. of Rochester, Rochester, NY (US)); Shoup, M.J.; Smith, D.L. pp. 203 of High power and solid state lasers II. Dubie, G SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (1989). (CONF-890157–: 2. conference on high power and solid state lasers, Los Angeles, CA (USA), 19-20 Jan 1989).

The authors discuss how they are designing an upgrade to its 24-beam OMEGA laser system, OMEGA is a frequency tripled, all-rod system capable of producing 2 kJ at 0.8 ns on target. Important direct-drive-target-ignition physics could be investigated with an upgraded system capable of producing a shaped pulse consisting of a long (5ns) low-intensity, foot, smoothly transitioning into a short (0.5 ns), intense, compression pulse. The total pulse energy is 30 kJ, which, from target-irradiation uniformity considerations, must be distributed over 60 beams.

20151 Scalar Green's-function derivation of the thermal blooming compensation instability equations. Morris, J.R. (Lawrence Livermore National Laboratory, Livermore, California 94550 (US)). *Journal of the Optical Society of America A: Optics and Image Science (USA)*, 6(12): 1859-1862 (Dec 1989). DOE Contract W-7405-ENG-48.

Karr [J. Opt. Soc. Am. A **6**, 1038 (1989)] recently derived an eigenvalue equation for the temporal growth rate of the thermal blooming compensation instability, using a Green's-function matrix formulation. A rigorous and concise derivation of all the Green's-function matrix elements is presented here for the case of arbitrary axial variation of the wind velocity and thermal blooming strength. Starting with the perturbation growth equation of the high-power beam in an arbitrary Galilean reference frame, the high-power and beacon-propagation equations are solved by the scalar Green's-function method. Although Green's function of the high-power beam equation has a closed form only in special cases, the general solution is useful as a rigorous basis for the Wentzel–Kramers–Brillouin approximation and for other approximations. Finally, the matrix closed-loop compensation equation is assembled from the Green's functions of the high-power beam, low-power beacon, and compensation subsystems.

43 PARTICLE ACCELERATORS

Refer also to citation(s) 19704

4301 Design, Development, and Operation

Refer also to citation(s) 20666, 21005

20152 (CEA-CONF–9894) **Reflection on the development of Nuclear Physics at intermediate energy.** Laget, J.M. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique Nucleaire a Haute Energie. 1989. 10p. (In French). (CONF-8905282–: 5. Saturne Meeting, Piriac (France), 16-20 May 1989). Order Number DE90752547. Available from NTIS (US Sales Only), PC A02/MF A01.

The role of Saturne and of a few GeV electron accelerator, for the future at Nuclear Physics at intermediate energy in Europe, is reviewed.

20153 (LBL–28106) **A small low energy cyclotron for radioisotope measurements.** Bertsche, K.J. Lawrence Berkeley Lab., CA (USA). Nov 1989. 149p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90006982. Available from NTIS, PC A07/MF A01; OSTI; INIS; GPO Dep.

Direct detection of ^{14}C by accelerator mass spectrometry has proved to be a much more sensitive method for radiocarbon dating than the decay counting method invented earlier by Libby. A small cyclotron (the "cyclotrino") was proposed for direct detection of radiocarbon in 1980. This combined the suppression of background through the use of negative ions, which had been used effectively in tandem accelerators, with the high intrinsic mass resolution of a cyclotron. Development of a small electrostatically-focused cyclotron for use as a mass spectrometer was previously reported but the sensitivity needed for detection of ^{14}C at natural abundance was not achieved. The major contributions of this work are the integration of a high current external ion source with a small flat-field, electrostatically-focused cyclotron to comprise a system capable of measuring ^{14}C at natural levels, and the analysis of ion motion in such a cyclotron, including a detailed analysis of phase bunching and its effect on mass resolution. A high current cesium sputter negative ion source generates a beam of carbon ions which is pre-separated with a Wien filter and is transported to the cyclotron via a series of electrostatic lenses. Beam is injected radially into the cyclotron using electrostatic deflectors and an electrostatic mirror. Axial focusing is entirely electrostatic. A microchannel plate detector is used with a phase-grated output. In its present form the system is capable of improving the sensitivity of detecting ^{14}C in some biomedical experiments by a factor of 10^4. Modifications are discussed which could bring about an additional factor of 100 in sensitivity, which is important for archaeological and geological applications. Possibilities for measurements of other isotopes, such as ^{3}H, and ^{10}Be, and ^{26}Al, are discussed. 70 refs.

4302 Beam Dynamics, Field Calculations, and Ion Optics

Refer also to citation(s) 20195, 20196, 21029, 21052

20154 (FNAL-TM–1635) **Luminosity calculation.** Hsueh, Shao-Yuan. Fermi National Accelerator Lab., Batavia, IL (USA). Dec 1989. 22p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. Order Number DE90006333. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The luminosity of the Tevatron collider was calculated. The data used for the calculation are the flying wire transverse beam profile and the SBD bunch profile. For the 900 GeV/c mini beta runs, the calculation was compared to the CDF luminosity monitor. The ratio of the calculation and C:BOLUMP is 0.95. 1 ref., 9 figs., 4 tabs.

20155 (LA-UR–90-315) **Beam-induced energy spreads at beam-pipe transitions.** Chan, K.C.D. Los Alamos National Lab., NM (USA). [1989]. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-8910357–1: Impedance and bunch instability workshop, Argonne, IL (USA), 30 Oct - 1 nov

1989). Order Number DE90006544. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Wakefields are induced when a beam bunch traverses a transition along the beam pipe. A transition can be a change of beam-pipe cross section either in shape or in size. These wakefields will, in turn, modify the kinetic energy of the beam bunch resulting in an energy spread in the beam. This paper will describe a simple picture for understanding these wakefields and the applications of this understanding to the design of beam-pipe transitions with minimized energy spread. Only longitudinal wakefields are considered in this paper. 2 refs., 6 figs.

20156 (TRI-PP-89-91) **Dynamics of heavy ion beams is an interdigital superconducting accelerator structure.** Fraser, J.S.; D'Auria, J.; Buchmann, L.; Schneider, H.R. British Columbia Univ., Vancouver, BC (Canada). TRIUMF Facility. Oct 1989. 5p. (CONF-891044–6: 1. international conference on radioactive nuclear beams, Berkeley, CA (USA), 16-18 Oct 1989). Order Number DE90006883. Available from NTIS (US Sales Only), PC A02/MF A01 - OSTI.

In 1985, a linac was proposed for the accelerated radioactive beams facility at TRIUMF. The linac comprised a low frequency (23 MHz) radiofrequency quadrupole (RFQ) structure followed by a conventional cw room temperature drift-tube linac. In this paper the use of a superconducting, interdigital structure for the linac is discussed and detailed beam dynamics calculations, using a modified version of the time-dependent PARMELA code are presented. A linac configuration for achieving a final energy of 1 MeV/amu is described. 8 refs., 5 figs., 1 tab.

20157 (UCRL–95121) **Dynamics of matching E-beams onto laser-ion channels.** Caporaso, G.J.; Cole, A.G.; Teague, M.R.; Yu, S.S. Lawrence Livermore National Lab., CA (USA). [1986]. 14p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-48. (CONF-8606153–9: DARPA conference, Albuquerque, NM (USA), 23-26 Jun 1986). Order Number DE90006996. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Analysis of the recent ATA propagation experiments revealed that there is an inherent "weakness" of the ion channel used to guide the beam through the accelerator. This weakness makes matching the beam onto the channel difficult, particularly for high current, low gamma beams. In addition, the ion-hose instability in the upstream matching region may explain the head-to-tail growth of beam size and hence, emittance observed in the propagation experiments. Finally, a new technique for matching beams onto ion channels that has been successfully used for low current, low emittance transport will be described. 3 refs., 5 figs.

20158 (UCRL–101472) **The fast correction coil feedback control system.** Coffield, F.; Caporaso, G.; Zentler, J.M. Lawrence Livermore National Lab., CA (USA). [1989]. 18p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-891094–15: International conference on accelerator and large experimental physics control systems, Vancouver (Canada), 30 Oct - 3 nov 1989). Order Number DE90006988. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A model-based feedback control system has been developed to correct beam displacement errors in the Advanced Test Accelerator (ATA) electron beam accelerator. The feedback control system drives an X/Y dipole steering system that has a 40-MHz bandwidth and can produce ±300-Gauss-cm dipole fields. A simulator was used to develop the control algorithm and to quantify the expected performance in the presence of beam position measurement noise and accelerator timing jitter. The major problem to date has been protecting the amplifiers from the voltage that is inductively coupled to the steering bars by the beam. 3 refs., 8 figs.

20159 (UCRL–102731) **The AMOS [Azimuthal MOde Simulator] wakefield code.** DeFord, J.F.; Craig, G.D.; McLeod, R.R. Lawrence Livermore National Lab., CA (USA). 23 Jan 1990. 25p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-48. (CONF-900163–4: Accelerator computer code meeting, Los Alamos, NM (USA), 22-25 Jan 1990). Order Number DE90007859. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

AMOS (Azimuthal MOde Simulator) is an electromagnetic simulation computer program that has been developed to study and design accelerator cavities. AMOS simulates the temporal evolution of fields in rotationally symmetric volumes, using a harmonic expansion in the azimuthal coordinate (ϕ) to project the fields onto a two-dimensional, r – z, finite-difference grid. An interactive preprocessor has been developed which allows the user to easily construct AMOS grids from geometric models. A wakefield postprocessor has also been developed to compute wake potentials and impedances from AMOS time-domain data. Graphical postprocessing software is presently under development. AMOS has been used to study accelerating modules in several linear accelerators, including the Advanced Test Accelerator (ATA), the Experimental Test Accelerator-II (ETA-II), SNOMAD, Dual Access Radiographic Hydrodynamics Test facility (DARHT), and others. Ongoing AMOS development objectives include the installation of an "open" boundary condition (Lindman), an rf tensor ferrite model, and the extension of AMOS to irregular, boundary conforming grids. 9 refs., 10 figs., 1 tab.

20160 (UCRL–102738) **Accelerator code simulation of FXR transport.** Boyd, J.K. Lawrence Livermore National Lab., CA (USA). 18 Jan 1990. 12p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900163–5: Accelerator computer code meeting, Los Alamos, NM (USA), 22-25 Jan 1990). Order Number DE90007861. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Three codes, DPC, ST and ENV have been used to study FXR transport. The main parameter that determines the success of FXR experiments is the beam emittance or equivalently the final spot size. It was found that most of the growth in emittance occurs just after the injector. This situation can be corrected if more diagnostics are made available to allow setting the magnetic profile to reduce radial oscillations. The codes have also been used to generate curves of beam rms radius at diagnostic locations for comparison with experimentally generated foil light. 3 refs., 9 figs.

20161 **Beam transport and focusing on PBFA II.** Lockner, T.R.; Johnson, D.J.; Mehlhorn, T.A.; Leeper, R.J.; Maenchen, J.E.; Stygar, W.A.; Coats, R.S.; Kensek, R.; Desjarlais, M.P.; Mendel, C.W. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Ion beam transport and focusing experiments on PBFA II are continuing to improve both the total energy transported to the axis and the peak power density measured on axis. A varied set of on and off axis diagnostics include an on axis ion pinhole camera, magnetic spectrograph, off axis K_α soft x-ray cameras, Faraday cups and witness plates. Diagnostics, transport theory, and simulations indicate that the the total energy on axis is limited by excessive vertical focusing by the applied and self fields. At present, the beam divergence is limiting the on axis horizontal FWHM to 5.5 mm for high power experiments. Experiments to determine the scaling and source of this divergence are continuing. The accelerator is now being operated reliably at the 3/4 energy level into an ion diode, and experimental results at this energy level are presented. Experimental results of ion diode operation with a POS are also presented.

20162 **Time-resolved diode current density measurements for the recirculating LINAC injector.** Haworth, M.D. (Sandia National Labs., Albuquerque, NM (USA)); Smith, D.L.; Mazarakis, M.G.; Poukey, J.W.; Hasti, D.E.; Bennett, L.F. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). DOE Contract AC04-76DP00789. (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Time and spatially-resolved beam electron current density measurements at the anode foil of the Recirculating Linear Accelerator (RLA) 1.5-MV, 15-kA isolate-Blumlein injector have been made using a beam aperture technique. This method derives the beam current density radial profile from the magnitude of the beam current exiting a range-thick aperture of varying radii centered on the

beam axis and placed in contact with the downstream side of the planar anode foil. Successful application of this diagnostic requires axisymmetric beams having good shot-to-shot reproducibility. The data analysis procedure, a comparison between the experimental results and a computer simulation of the RLA diode are presented.

20163 Automation of particle accelerator control. Silbar, R.R. (Los Alamos National Lab., NM (USA)); Schultz, D.E. pp. 582 of Computers in engineering. 1988. Tipnis, V.A.; Patton, E.M American Society of Mechanical Engineers, New York, NY (1988). (CONF-880719–: ASME international computers in engineering conference and exhibition, San Francisco, CA (USA), 31 Jul - 4 aug 1988).

The authors have begun a program aiming toward automatic control of charged-particle beam optics using artificial intelligence programming techniques. In developing their prototype, they are working with LISP machines and the KEE expert system shell. Their first goal was to develop a mouseable representation of a typical beamline. This responds actively to changes input from the mouse or keyboard, giving an updated display of the beamline itself, its optical properties, and the instrumentation and control devices as seen by the operator. They have incorporated the Fortran beam optics code TRANSPORT for simulation of the beam. The paper describes the experience gained in this process and discusses plans to extend the work so that it is usable, in real-time, on an operating beamline.

4303 Auxiliaries and Components

Refer also to citation(s) 20158, 20161, 20614, 21020, 21038, 21039

20164 (BNL–40651, pp. 1-4) **Model-based accelerator controls what, why and how.** Sidhu, S.S. Brookhaven National Lab., Upton, NY (USA). Dec 1987. (CONF-8708145–: Workshop on model based accelerator controls, Upton, NY (USA), 16-18 Aug 1987). In *Proceedings: Workshop on model-based accelerator controls.* Order Number DE88006366. Available from NTIS, PC A05/MF A01.

Conventional accelerator control systems are collections of hardware and programs intended to: receive operator requests for changes in magnet current settings and to set the currents to requested values. Convey information about the state of the beam from the instrumentation to the operator (usually after some processing). Perform similar functions in respect of other sub-systems of an accelerator, e.g., the RF, vacuum and cryogenic systems. These programs have evolved to possess varying degrees of user friendliness in that they permit the operator to enter and receive information in a form that is related more or less logically to the particular sub-system being controlled. The important point is that the operator is not a passive link in the system. Instead, he is to be seen as an important information processing node. Even more, he is a node at which information is selectively injected into the system to bring it to the desired state. A key component of the knowledge base of the operator is a model of the accelerator. As accelerators become more complex and the operating requirements become more stringent, the reliability and performance of this node becomes a crucial factor in fast commissioning and start-up and continued stable operation at optimum efficiency. Model-based control (MBC) is, the term for the gamut of techniques whose aim is to improve the reliability and enhance the capabilities of the operator, and therefore of the whole control system. The aim of model-based control is, then, to gradually move the function of model-reference from the operator to the computer.

20165 (BNL–40651, pp. 17-26) **More madness.** Niederer, J. Brookhaven National Lab., Upton, NY (USA). Dec 1987. (CONF-8708145–: Workshop on model based accelerator controls, Upton, NY (USA), 16-18 Aug 1987). In *Proceedings: Workshop on model-based accelerator controls.* Order Number DE88006366. Available from NTIS, PC A05/MF A01.

The programming environment of the Methodical Accelerator Design (MAD) series of programs is surveyed, with an emphasis on features related to control systems software. MAD is a comprehensive set of accelerator programs, originally integrated by F.C. Iselin and E. Keil at CERN. It is a modern, interactive and network oriented tool kit serving accelerator design, theory, and practice needs. In summary, MAD now has cell matching, optical function, tracking, simulated error, orbit correction, harmonic, and electron spin polarization features, with others in progress. Its full contents, with references to its contributors and antecedents are documented extensively in a User's Manual (2) and a Programmer's Manual (3), with a Physicist's Manual in progress (4). It is almost computer system independent, currently running on those of IBM, Vax, Unix, Appolo, CDC, and Cray machines. At BNL it is maintained and enhanced on SUN-Unix Workstations; at CERN this is done on large IBM systems. 14 refs.

20166 (BNL–40651, pp. 39-40) **Model based controls and the AGS booster controls system architecture.** Casella, R.A. Brookhaven National Lab., Upton, NY (USA). Dec 1987. (CONF-8708145–: Workshop on model based accelerator controls, Upton, NY (USA), 16-18 Aug 1987). In *Proceedings: Workshop on model-based accelerator controls.* Order Number DE88006366. Available from NTIS, PC A05/MF A01.

For the past three years the Accelerator Controls Section has been responsible for the development of the Heavy Ion Transfer Line (HITL) used to inject heavy ions created at the Tandem Van de Graaff into the Alternating Gradient Synchrotron (AGS). This was recognized as an opportunity to test new ideas for control of a beam line, which if successful, could be implemented in an upgrade of the existing control system for the AGS. The in place control system for the AGS consisted of DEC PDP10 computer as the primary computer interface to the accelerator via three control room consoles, and keeper of the device database. For the HITL project it was decided to make the control system a true distributed network putting more computing power down at the device level via intelligent subsystems. A network of Apollo workstations was added at the host level. Apollos run a distributed operating system and are connected to each other by the Domain Token Ring Network. The Apollos were seen as the new primary computers for consoles with each console containing at least one Apollo. These hosts and all other subsystems are connected to each other via an in house developed LAN (RELWAY). The design of the control system developed for HITL was mostly successful. The proposed AGS Booster is designed to be a synchrotron injector for the AGS. With the forthcoming development of the Booster for the AGS an opportunity has again developed to implement new ideas for accelerator control. One weakness of the HITL control system is the limited cpu power and poor debugging facilities of the stations.

20167 (BNL–40651, pp. 41-52) **Overview of the TRISTAN control system.** Kurokawa, Shinichi (National Lab. for High Energy Physics, Ibaraki (Japan)). Brookhaven National Lab., Upton, NY (USA). Dec 1987. (CONF-8708145–: Workshop on model based accelerator controls, Upton, NY (USA), 16-18 Aug 1987). In *Proceedings: Workshop on model-based accelerator controls.* Order Number DE88006366. Available from NTIS, PC A05/MF A01.

Twenty-four distributed minicomputers, Hitachi HIDIC 80E's and HIDIC 80M's, are connected by optical fiber cables to form a 10-Mbps token-ring network. NODAL, a multi-computer interpreter language devised at CERN SPS, has been implemented on HIDIC 80's with enhancements such as a fast execution speed, a dynamic linkage scheme for external subroutines, etc. All high-level application programs were coded in NODAL, which have needed more than 35 man-year efforts. Accelerators are operated through five identical operator's consoles which consists of two high-resolution color graphic CRT terminals, a pair of touch panels and a VT100 terminal used for interactive programming. Modeling and simulation procedures used in the TRISTAN control system are described. 5 refs., 6 figs.

20168 (BNL–40651, pp. 53-64) **Merging AI and numerical modeling for accelerator control.** Schultz, D.E. (Los Alamos National Lab., NM (USA)); Silbar, R.R. Brookhaven National Lab., Upton, NY (USA). Dec 1987. (CONF-8708145–: Workshop on model based accelerator controls, Upton, NY (USA), 16-18 Aug 1987). In *Proceedings: Workshop on model-based accelerator controls.* Order Number DE88006366. Available from NTIS, PC A05/MF A01.

The authors report the beginnings of an experiment to evaluate the power and limitations of artificial intelligence techniques combined with beam-line modeling for solving problems in accelerator control. Using the Knowledge Engineering Environment (KEE) system, they have built a knowledge base that describes the characteristics and the relationships of about 30 devices in a typical accelerator beam line. Each device in the line is categorized and pertinent attributes for each category are defined. Specific values for each device are assigned in the knowledge base to represent static characteristics. Device-specific slots are also provided for dynamic attributes. The definition of these slots reflects the data type and any limitations or restrictions on the range of the data. The authors model relationships between the various beam-line devices using the techniques of rules, active values, and object-oriented models. The knowledge base provides a framework for analyzing faults and offering suggestions to assist in tuning, based on information provided by the accelerator physicists (domain experts) responsible for designing and tuning this beam line. Our knowledge base has a powerful graphical interface. It allows the operator to mouse on an icon for a particular icon in the schematic of the beam line and obtain device-specific information and control over that device. The beam optics code Transport is used to model the beam line numerically. 11 refs., 7 figs.

20169 (BNL–40651, pp. 65-76) **The representation of knowledge within model-based control systems.** Weygand, D.P.; Koul, R. Brookhaven National Lab., Upton, NY (USA). Dec 1987. (CONF-8708145–: Workshop on model based accelerator controls, Upton, NY (USA), 16-18 Aug 1987). In *Proceedings: Workshop on model-based accelerator controls.* Order Number DE88006366. Available from NTIS, PC A05/MF A01.

The ability to represent knowledge is often considered essential to build systems with reasoning capabilities. In computer science, a good solution often depends on a good representation. The first step in development of most computer applications is selection of a representation for the input, output, and intermediate results that the program will operate upon. For applications in artificial intelligence, this initial choice of representation is especially important. This is because the possible representational paradigms are diverse and the forcing criteria for the choice are usually not clear in the beginning. Yet, the consequences of an inadequate choice can be devastating in the later state of a project if it is discovered that critical information cannot be encoded within the chosen representational paradigm. Problems arise when designing representational systems to support any kind of Knowledge-Base System, that is a computer system that uses knowledge to perform some task. The general case of knowledge-based systems can be thought of as reasoning agents applying knowledge to achieve goals. Artificial Intelligence (AI) research involves building computer systems to perform tasks of perception and reasoning, as well as storage and retrieval of data. The problem of automatically perceiving large patterns in data is a perceptual task that begins to be important for many expert systems applications. Most of AI research assumes that what needs to be represented is known a priori; an AI researcher's job is just figuring out how to encode the information in the system's data structure and procedures. 10 refs.

20170 (BNL–40651, pp. 77-85) **Towards portability in model-based control software.** Paxson, V. (Lawrence Berkeley Lab., CA (USA)); Theil, E. Brookhaven National Lab., Upton, NY (USA). Dec 1987. (CONF-8708145–: Workshop on model based accelerator controls, Upton, NY (USA), 16-18 Aug 1987). In *Proceedings: Workshop on model-based accelerator controls.* Order Number DE88006366. Available from NTIS, PC A05/MF A01.

A couple of recent developments offer the possibility of reusing accelerator control software: Model-based control software, i.e., software designed around one or more models of the control process, does not have the problem of assumptions about the input data. As long as the input data can be plugged into the model, the software can operate on it, because it does not have the particulars of a control system wired into it. Emerging graphics standards offer a way to design software such that the assumptions made about the output to generate will remain valid when the software is moved from one type of computer to another. We take graphics to mean not only the now-familiar pictorial displays like data plots but window systems, such as those available on scientific workstations, as well. In light of these developments, the crucial part of making accelerator control software portable, i.e., reusable on different accelerator control systems and on different computers, remains the software's design - the basic structure of the program. In particular, given a sound design, it is possible to change how the software acquires the data for its model, and how it does its graphical output, with no change necessary to the main body of the code. On the output side of things, this extends to being able to adapt the software to a different, non-standard graphics environment with minimal effort. 4 refs., 7 figs.

20171 (CEA-CONF–9836) **Half wave helix loaded superconducting resonator for heavy Ion Linac.** Cauvin, B.; Fouan, J.P.; Girard, J.; Ramstein, G. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Physique Nucleaire. 1989. 3p. (CONF-890335–: 13. particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989). Order Number DE90752549. Available from NTIS (US Sales Only), PC A02/MF A01.

We report here the main characteristics and performances of the helix superconducting resonators designed and mounted in the new Saclay Booster Linac which is the first european heavy ion superconducting accelerator.

20172 (CEA-CONF–9843) **Undulator for the CLIO project at Orsay.** Carlos, P.J. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique Nucleaire a Haute Energie (France)); Bourgeois, P.; Fallou, J.L.; Garganne, P.; Hezard, C.; Lepretre, A.; Bazin, C.; Ortega, J.M. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique Nucleaire a Haute Energie. 1989. 6p. (CONF-8904242–: International congress on optical science and engineering, Paris (France), 24-28 Apr 1989). Order Number DE90752530. Available from NTIS (US Sales Only), PC A02/MF A01.

The CLIO collaboration (Collaboration pour un Laser Infrarouge a Orsay) started in 1986, in order to build an infrared laser at LURE (Orsay). It includes the design and the construction of a new FEL dedicated RF linear accelerator, to make a tunable laser in a broad wavelength range (typically 2- 20 mum) with a peak power in the MW range and an average power of a few tens of watts. In order to obtain enough gain at low wavelength (lambda $\simeq$ 2 mum) together with a good energy extraction at long wavelength, a two component undulator has been designed and built. It is made of two identical 1=0.96 m long undulators with a computer controlled and automatically adjustable magnetic gap, the second undulator being possibly tapered. The undulator period was chosen as $lambda_0$=4 cm. Preliminary calculations indicated that the regime in which a half length constant gap undulator is followed by a tapered one provides the best energy extraction. To adjust easily the FEL wavelength, the non hybrid technology was chosen. With a judicious choice of a few electron energies the spectral region from 2 to 20 mum can be spanned by varying the undulator gap between 10 and 30 mm.

20173 (CONF-8910349–1) **High-field superconducting magnets for particle accelerators.** Perin, R. European Organization for Nuclear Research, Geneva (Switzerland). 13 Oct 1989. 20p. Sponsored by European Organization for Nuclear Research. From INFN Eloisatron Project workshop on high intensity storage rings: status and prospects for superconducting magnets; Erice (Italy); 16-23 Oct 1989. Order Number DE90002570. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI.

Particle Physics requires higher and higher energy accelerators/colliders to explore the fundamental components of matter. For electron/positron accelerators, circular machines, which make use of low bending magnetic field to limit synchrotron radiation, have probably reached their maximum size with LEP and the trend for the future is towards linear facilities. For high energy hadron accelerators/colliders, superconducting magnets have been adopted in order to save electrical energy and reduce machine size, and the quest for cost efficiency pushes towards higher field. The 9 to 10 tesla range has already been attained in short dipole magnets. The large proton accelerators/colliders presently under construction, approved or planned represent the largest scale application of superconductivity and require massive production in industry of advanced technology conductors, magnets and cryogenic equipment.

A review is given of the magnets for these projects and of the future trends supported by R&D programs. 32 refs., 14 figs.

20174 (DOE/ER/40121–T3) **[Acoustic emission diagnostic techniques for high-field high current-density super inducting poles].** Massachusetts Inst. of Tech., Cambridge, MA (USA). Plasma Fusion Center. [1990]. 32p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-83ER40121. Order Number DE90007400. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Acoustic emission technology was introduced in the late 1970's to monitor superconducting magnets. It has now been firmly established that acoustic signals in superconducting magnets are emitted principally by mechanical events such as conductor strain, conductor motion, frictional motion, and epoxy cracking. Despite earlier suggestions, flux motion, except during flux jumping, does not appear to be an important source of AE signals in superconducting magnets. Of these several potential sources of AE signals in superconducting magnets, mechanical disturbances have been identified to be most important in high-performance, "adiabatic" magnets such as the dipoles used in accelerators. These mechanical disturbances are transitory, each generating a packet of AE signals that can be located with sensors. Source identification and location has been achieved with a number of superconducting magnets. In this section, the basic principle for the operation of adiabatic magnets is discussed, followed by presentation of some of the important experimental results relevant to the question of premature quench obtained at MIT.

20175 (FNAL-TM–1639) **The bellows at low beta and beam stabilities.** Ng, King-Yuen. Fermi National Accelerator Lab., Batavia, IL (USA). Nov 1989. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. Order Number DE90007233. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Tevatron dipoles and quadrupoles are at superconducting temperature while the low-beta insertion is at room temperature. In order to limit the heat flowing into the low temperature region, the low-beta insertion is joined to the ring through a special bellows. The beam-pipe radius is 3.7 cm corresponding to a cutoff frequency of 3.10 GHz for the monopole mode and 2.38 GHz for the dipole mode. There are approximately 32 such bellows. Each bellows has a narrow gap of about 6 mm at the beam pipe and opens up into a $\sim$ 7 cm wide cavity at larger radius. The bellows ripples start at a radius of about 12 cm. We therefore expect the bellows to contribute sharp resonances below cutoff at frequency below 1 GHz. In this article, we are going to compute the longitudinal and transverse impedances and to check whether they can drive any collective instabilities of the beam bunches. 4 figs., 3 tabs.

20176 (FNAL-TM–1642) **Future microprocessor farms: Offline and online.** Areti, H. Fermi National Accelerator Lab., Batavia, IL (USA). 12 Jan 1990. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. Order Number DE90006331. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Microprocessor farms have been successfully employed in high energy physics for both offline analysis and online triggers. As the experiments continue to grow in size, so do the demands for processing power. The preliminary indications are that the large collider experiments will require at least a million VAX-11/780 equivalents of processing power for online trigger decisions and offline event reconstruction. This paper examines the current technology trends and projects the processing power that may be expected with the current farm architectures. 3 refs., 6 figs.

20177 (FNAL-TM–1643) **Mass storage for microprocessor farms.** Areti, H. Fermi National Accelerator Lab., Batavia, IL (USA). 12 Jan 1990. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. Order Number DE90006332. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Experiments in high energy physics require high density and high speed mass storage. Mass storage is needed for data logging during the online data acquisition, data retrieval and storage during the event reconstruction and data manipulation during the physics analysis. This paper examines the storage and speed requirements at the first two stages of the experiments and suggests a possible starting point to deal with the problem. 3 refs., 3 figs.

20178 (GSI–89-26) **Modification of an ion source for the ion-beam supported coating of construction parts.** Wituschek, H. Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.); Heidelberg Univ. (Germany, F.R.). Oct 1989. 58p. (In German). Order Number DE90753487. Available from NTIS (US Sales Only), PC A04/MF A01.

A high-current ion source at the Society for Heavy Ion Physics was modified in such a way, that it can be applied in an installation for ion-beam supported coating. The ion beam produced has the following properties: The ion beam current amounts to 80 mA at an ion energy of 25 keV. The beam has a diameter of 220 mm. The beam intensity decreases over this area by not more than 30%. This is indeed only valid for charged particles. Following steps were performed: Ion beams with numerous extraction geometries were numerically simulated. By means of the simulation a multi-aperture extraction was found which produces a beam with the above properties. On the base of the results from the simulation extraction electrodes were manufactured. For the testing of the simulation results a test facility for the diagnostics of a large-area ion beam was built. A measurement facility for the determination of the current density profile was constructed. The measurement facility consists of four Faraday cups with mechanics which allow a beam-profile measurement on an area of 300x300 mm^2. The uptaking of a current density profile is computer-guided. With this apparatus numerous measurements of the current density profile of different extractions at different parameters of the ion source were performed. The large contribution of neutral particles represents a problem for the use of the ion beam. For the optimal application of the ion source in a coating facility the distribution of the neutral particles should be precisely measured and if possible lowered. (orig.).

20179 (GSI–89-28) **Properties of spiral resonators.** Haeuser, J. Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.); Frankfurt Univ. (Germany, F.R.). Oct 1989. 100p. (In German). Order Number DE90753486. Available from NTIS (US Sales Only), PC A05/MF A01.

The present thesis deals with the calculation and the study of the application possibilities of single and double spiral resonators. The main aim was the development and the construction of reliable and effective high-power spiral resonators for the UNILAC of the GSI in Darmstadt and the H^--injector for the storage ring HERA of DESY in Hamburg. After the presentation of the construction and the properties of spiral resonators and their description by oscillating-circuit models the theoretical foundations of the bunching are presented and some examples of a rebuncher and debuncher and their influence on the longitudinal particle dynamics are shown. After the description of the characteristic accelerator quantities by means of an oscillating-circuit model and the theory of an inhomogeneous $\lambda/4$ line it is shown, how the resonance frequency and the efficiency of single and double spiral resonators can be calculated from the geometrical quantities of the structure. In the following the dependence of the maximal reachable resonator voltage in dependence on the gap width and the surface of the drift tubes is studied. Furthermore the high-power resonators are presented, which were built for the different applications for the GSI in Darmstadt, DESY in Hamburg, and for the FOM Institute in Amsterdam. (orig./HSI).

20180 (GSI–89-29) **Field sparking in electric high-frequency fields.** Gerhard, A. Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.); Frankfurt Univ. (Germany, F.R.). Oct 1989. 118p. (In German). Available from Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.). Available from Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.).

The operation of particle accelerators is limited by the maximal onlayable voltage, at which still no sparks occur. The experiments performed in the framework of this thesis served for the aim to study surface-treatment methods, by means of which the spark limit can be increased, and in order to understand better the causes and the mechanisms of these field sparks. In a $\lambda/4$ coaxial resonator and a RFQ with an operational frequency of 108.5 MHz the spark behaviour and the field emission current were studied in dependence on the split voltage for split width between 4 and 8

mm and a touching ratio between 1 and 100% for Cu, CrCu, SiO_2, Pt, Al, and V2A electrodes at a pressure of about $1x10^{-5}$ Pa. Thereby field strengths between 60 MV/m at 10% touching ratio and 35 MV/m at 100% could be reached. For the study of the frequency dependence additionally a double coaxial resonator with an operational frequency of 216 MHz was used. The measurement of the split voltage was performed at times during the high-power operation, whereby a bremsspectrum was taken up with a germanium detector. By this the maximal photon energy, which occurs in the bremsspectrum, was determined. This limit indicates directly the split voltage with an accuracy of $\leq$ 1%. This method allows additionally a precise determination of the Rp value of the resonance structure. (orig.).

20181 (LA-UR-90-383) **Fifth-order aberrations in magnetic quadrupole-octupole systems.** Ling, K.M. Los Alamos National Lab., NM (USA). [1990]. 75p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-900163-3: Accelerator computer code meeting, Los Alamos, NM (USA), 22-25 Jan 1990). Order Number DE90007489. Available from NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

Explicit integral expressions are given for the fifth-order geometrical aberration coefficients in rectilinear magnetic quadrupole-octupole systems used for the transport of nonrelativistic charged particle beams. The numerical values of the fifth-order geometrical aberration coefficients for a rare earth cobalt (REC) quadrupole doublet are given as an example. 26 refs., 5 figs., 4 tabs.

20182 (LBL-27953) **Injector for RFQ using electrostatically focused transport and matching.** Anderson, O.A.; Soroka, L.; Kwan, J.W.; Wells, R.P. Lawrence Berkeley Lab., CA (USA). Nov 1989. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Contract MIPR W31RPD-63A087. (CONF-891055-10: 5. international symposium on the production and neutralization of negative ions and beams, Upton, NY (USA), 30 Oct - 3 nov 1989). Order Number DE90007067. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We discuss the principles and performance of a new type of high-current H^- injector for RFQs. The distinguishing feature of our injector is that we replace the conventional gas-neutralized transport and matching units by electrostatic focusing units. Our system prevents plasma formation along the beam instead of utilizing it. Some advantages of this approach are discussed. 13 refs., 6 figs.

20183 (LBL-27965) **A continuous plasma final focus.** Whittum, D.H. Lawrence Berkeley Lab., CA (USA). Nov 1989. 22p. Sponsored by U.S. DOE Energy Research; National Laboratory for High Energy Physics (Japan). DOE Contract AC03-76SF00098. (CONF-8908209-1: Workshop on the role of plasmas in accelerators, Tsukuba (Japan), 28 Aug - 1 sep 1989). Order Number DE90006096. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Scaling laws are set down for a plasma cell used for transport, focusing and current neutralization of fine, intense, relativistic electron beams. It is found that there exists a minimum beam spot size, $\sigma_{min} \sim \varepsilon_n(I_A/\gamma I)^{1/2}$, in such a focusing system. Propagation issues, including channel formation, synchrotron radiation, beam ionization and instabilities, are discussed. Numerical examples are given for a proof-of-principle experiment at KEK, an application for luminosity enhancement at the SLC, and a hypothetical TeV electron-positron collider. For a TeV collider, it is found that the effect of ion-motion on focusing, and the effect of Buneman instability on current neutralization must be considered. 3 figs., 1 tab.

20184 (LBL-28113) **H^- production from non-cesiated converter-type negative ion sources.** van Os, C.F.A.; Leung, K.N.; Lietzke, A.F.; Stearns, J.W.; Kunkel, W.B. Lawrence Berkeley Lab., CA (USA). Nov 1989. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-891055-11: 5. international symposium on the production and neutralization of negative ions and beams, Upton, NY (USA), 30 Oct - 3 nov 1989). Order Number DE90007066. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Recent results of surface produced negative ions are presented. Two low work function metal surfaces have been studied, barium and magnesium, in combination with several plasma generators; rf- and dc-filament discharges. The negative ion yield for barium is about 5 to 6 times larger than magnesium. This ratio is confirmed by model calculations on resonant charge exchange. 32 refs., 9 figs.

20185 (SAND-89-1890) **The inverse triax x-ray diode—an alternate reduced-endpoint-energy bremsstrahlung source.** Harper-Slaboszewicz, V.J. (Sandia National Labs., Albuquerque, NM (USA)); Poukey, J.W.; Stygar, W.A.; Fowler, W.E.; Peyton, B. Sandia National Labs., Albuquerque, NM (USA). Feb 1990. 32p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC04-76DP00789. Order Number DE90006366. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The inverse triax diode is a high power, low impedance electron diode which offers significant advantages over conventional electron diodes on short-pulse (<30 ns FWHM) high power x-ray simulators. Parametric calculations show that the radiation efficiency of the inverse triax is competitive with standard diodes fro mean photon energies below about 120 keV, and sometimes up to 150 keV. Particle-in-cell code simulations show the impedance behavior and flow pattern in the inverse triax with and without the presence of an anode plasma. The simulation results are used to suggest design rules for inverse triax diodes. Experimental results show good agreement with calculations of the impedance behavior and electron beam dynamics. Using inverse triax diodes, we have produced peak doses of 1.4×10^{11} rad(TLD)/s over 840 cm^2 with a mean photon energy of 120 keV on SPEED and 3.1×10^{11} rad(TLD)/s over 3700 cm^2 with a mean photon energy of 140 keV on Saturn. 20 refs., 16 figs.

20186 (SLAC-CN-375) **Linac BPM [Beam Position Monitor] modification program status.** Smith, S.; Williams, S. Stanford Linear Accelerator Center, Menlo Park, CA (USA). 10 Feb 1990. 2p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. Order Number DE90007570. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

In the fall of 1988 the Beam Position Monitor (BPM) Task Force recommended that linac BPM processors be pulled out of the linac, modified, adjusted for offsets, recalibrated, and reinstalled. As of the end of 1989 this process had been completed on all linac type BPM processors. This paper discusses these modifications and tests.

20187 (SLAC-PUB-5035) **Computation and control with neural nets.** Corneliusen, A.; Terdal, P.; Knight, T.; Spencer, J. Stanford Linear Accelerator Center, Menlo Park, CA (USA). 4 Oct 1989. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (CONF-891094-14: International conference on accelerator and large experimental physics control systems, Vancouver (Canada), 30 Oct - 3 nov 1989). Order Number DE90006460. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

As energies have increased exponentially with time so have the size and complexity of accelerators and control systems. NN may offer the kinds of improvements in computation and control that are needed to maintain acceptable functionality. For control their associative characteristics could provide signal conversion or data translation. Because they can do any computation such as least squares, they can close feedback loops autonomously to provide intelligent control at the point of action rather than at a central location that requires transfers, conversions, hand-shaking and other costly repetitions like input protection. Both computation and control can be integrated on a single chip, printed circuit or an optical equivalent that is also inherently faster through full parallel operation. For such reasons one expects lower costs and better results. Such systems could be optimized by integrating sensor and signal processing functions. Distributed nets of such hardware could communicate and provide global monitoring and multiprocessing in various ways e.g. via token, slotted or parallel rings (or Steiner trees) for compatibility with existing systems. Problems and advantages of this approach such as an optimal, real-time Turing machine are discussed. Simple examples are simulated and hardware implemented using discrete elements that demonstrate some basic characteristics of learning and parallelism. Future 'microprocessors' are predicted and requested on this basis. 19 refs., 18 figs.

20188 (SLAC-PUB-5112) **Initial performance of the Wire Imaging Synchrotron Radiation Detector.** Von Zanthier, C. (California Univ., Santa Cruz, CA (USA)); Gomez Cadenas, J.J.; Kent, J.; King, M.; Watson, S.; Briggs, D.D.; Rouse, F.; Tinsman, J. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jan 1990. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515;AC03-76SF00098;AM03-76SF00010. (CONF-900143-24: Institute for Electronic and Electrical Engineers (IEEE) nuclear science symposium, San Francisco, CA (USA), 22-26 Jan 1990). Order Number DE90006458. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This paper describes the initial performance of a novel detector that measures the positions of intense synchrotron-radiation beams with high precision. Two detectors of this kind are used for the precision energy spectrometers of the Stanford Linear Collider (SLC). The detectors accurately determine the distance between pairs of intense synchrotron beams of typically 1 MeV photons, which are emitted by the primary electron and positron beams of the SLC. The detectors intercept the synchrotron beams with arrays of fine wires. The ejection of Compton-recoil electrons leaves positive charges on the wires, enabling a determination of beam positions. 6 refs., 6 figs.

20189 (SLAC-PUB-5119) **The scalable coherent interface, IEEE P1596, status and possible applications to data acquisition and physics.** Gustavson, D.B. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jan 1990. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (CONF-900143-26: Institute for Electronic and Electrical Engineers (IEEE) nuclear science symposium, San Francisco, CA (USA), 22-26 Jan 1990). Order Number DE90006454. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

IEEE P1596, the Scalable Coherent Interface (formerly known as SuperBus) is based on experience gained while developing Fastbus (ANSI/IEEE 960-1986, IEC 935), Futurebus (IEEE P896.x) and other modern 32-bit buses. SCI goals include a minimum bandwidth of 1 GByte/sec per processor in multiprocessor systems with thousands of processors; efficient support of a coherent distributed-cache image of distributed shared memory; support for repeaters which interface to existing or future buses; and support for inexpensive small rings as well as for general switched interconnections like Banyan, Omega, or crossbar networks. This paper presents a summary of current directions, reports the status of the work in progress, and suggests some applications in data acquisition and physics. 7 refs.

20190 (SLAC-PUB-5135) **A precision synchrotron radiation detector using phosphorescent screens.** Jung, C.K. (Stanford Linear Accelerator Center, Menlo Park, CA (USA)); Lateur, M.; Nash, J.; Tinsman, J.; Butler, J.; Wormser, G.; Levi, M.; Rouse, F. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jan 1990. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515;AC03-76SF00098;AM03-76SF00010. (CONF-900143-25: Institute for Electronic and Electrical Engineers (IEEE) nuclear science symposium, San Francisco, CA (USA), 22-26 Jan 1990). Order Number DE90006457. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A precision detector to measure synchrotron radiation beam positions has been designed and installed as part of beam energy spectrometers at the Stanford Linear Collider (SLC). The distance between pairs of synchrotron radiation beams is measured absolutely to better than 28 μm on a pulse-to-pulse basis. This contributes less than 5 MeV to the error in the measurement of SLC beam energies (approximately 50 GeV). A system of high-resolution video cameras viewing precisely aligned fiducial wire arrays overlaying phosphorescent screens has achieved this accuracy. 3 refs., 5 figs., 1 tab.

20191 (SLAC-PUB-5183) **Numerical simulation of cross field amplifiers.** Eppley, K. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jan 1990. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (CONF-900163-2: Accelerator computer code meeting, Los Alamos, NM (USA), 22-25 Jan 1990). Order Number DE90006459. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Cross field amplifiers (CFA) have been used in many applications where high power, high frequency microwaves are needed. Although these tubes have been manufactured for decades, theoretical analysis of their properties is not as highly developed as for other microwave devices such as klystrons. One feature distinguishing cross field amplifiers is that the operating current is produced by secondary emission from a cold cathode. This removes the need for a heater and enables the device to act as a switch tube, drawing no power until the rf drive is applied. However, this method of generating the current does complicate the simulation. We are developing a simulation model of cross field amplifiers using the PIC code CONDOR. We simulate an interaction region, one traveling wavelength long, with periodic boundary conditions. An electric field with the appropriate phase velocity is imposed on the upper boundary of the problem. Evaluation of the integral of E-J gives the power interchanged between the wave and the beam. Given the impedance of the structure, we then calculate the change in the traveling wave field. Thus we simulate the growth of the wave through the device. The main advance of our model over previous CFA simulations is the realistic tracking of absorption and secondary emission. The code uses experimental curves to calculate secondary production as a function of absorbed energy, with a theoretical expression for the angular dependence. We have used this code to model the 100 MW X-band CFA under construction at SLAC, as designed by Joseph Feinstein and Terry Lee. We are examining several questions of practical interest, such as the power and spectrum of absorbed electrons, the minimum traveling wave field needed to initiate spoke formation, and the variation of output power with dc voltage, anode-cathode gap, and magnetic field. 5 refs., 8 figs.

20192 (TRI-PP-89-92) **The TISOL facility at TRIUMF.** D'Auria, J. (Simon Fraser Univ., Burnaby, BC (Canada). Dept. of Chemistry); Dombsky, M.; Buchmann, L.; Sprenger, H.; Vincent, J. British Columbia Univ., Vancouver, BC (Canada). TRIUMF Facility. Oct 1989. 6p. (CONF-891044-5: 1. international conference on radioactive nuclear beams, Berkeley, CA (USA), 16-18 Oct 1989). Order Number DE90006882. Available from NTIS (US Sales Only), PC A02/MF A01 - OSTI.

The TISOL facility at TRIUMF is now an operational on-line isotope separator, capable of delivering ion beams for over 100 radioisotopes from two different types of ion sources including an Electron Cyclotron Resonance (ECR) source, and is now entering a phase which it can be used productively for basic physics research. The purpose of this report is to provide a summary progress report on this new facility including observed production yields and details of the new ECR installation. The plans for the future development of the facility to perhaps use proton beams of intensities approaching 5 microamps will also be discussed. The status of the proposed ISAC facility will also be reviewed. 11 refs., 4 figs., 3 tabs.

20193 (TRI-PP-89-100) **Computerized analysis of hydrogen plasma in a compact H^- cusp source.** Yuan, D.H.; Jayamanna, K.; Schmor, P.W. British Columbia Univ., Vancouver, BC (Canada). TRIUMF Facility. Nov 1989. 11p. (CONF-891055-12: 5. international symposium on the production and neutralization of negative ions and beams, Upton, NY (USA), 30 Oct - 3 nov 1989). Order Number DE90006881. Available from NTIS (US Sales Only), PC A02/MF A01 - OSTI.

A cylindrical Langmuir probe with diam of 0.5 mm, length of 5 mm and the Laframboise theory are used to give an analysis of the plasma parameters in a H^- cusp source including temperatures and densities of slow, fast electrons and positive ions in a median density plasma. The iteration technique overcomes the problems of conventional Langmuir probe analysis. A VAX based program is used to control the motion and analyze data from the probe. In this paper, we briefly describe the program and present initial results obtained from a compact H^- volume multicusp source. 4 refs., 8 figs.

20194 (UCRL-100890) **Relativistic klystron wakefields.** Yu, D.U.L. (Duly Consultants, Rancho Palos Verdes, CA (USA)); Craig, G.D.; DeFord, J.F. Lawrence Livermore National Lab., CA (USA). 14 Apr 1989. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-890335-274: 13. particle

accelerator conference, Chicago, IL (USA), 20-23 Mar 1989). Order Number DE90006990. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Monopole, dipole and quadrupole wake potentials are calculated for two cavities in a standing-wave relativistic klystron, using two independent programs, TBCI and AMOS. Reflections from model terminations which may distort long-range wakes can be mitigated either by using a very long pipe or by using absorptive materials at the pipe boundaries. 7 refs., 10 figs.

20195 **Ion beam effects on K-shell emission from high temperature plasmas on PBFA II.** Dukart, R.J. (Sandia National Labs., Albuquerque, NM (USA)). pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184--: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

K-shell emission from H-, He-, and Li-like ions can be used to diagnose electron temperature and density conditions in ICF plasmas. Interpretation of that emission in the ion beam interaction region on PBFA II is complicated by the presence of the intense ion beam. The author has added ion beam ionization and excitation (as well as the inverse processes) to the C.R.E. code RATION. The ion beam is assumed to be monoenergetic and fully ionized. The ion beam ionization rates are derived from scaled values of the ionization cross sections. The ion beam excitation cross sections are scaled from the electron excitation cross sections. All inverse processes are obtained from detailed balance. The inclusion of the ion beam effects into the code is described. An analysis of the effects on diagnostic line ratios is presented.

20196 **Energy-resolved imaging of the PBFA-II ion beam.** Stygar, W.A. (Sandia National Labs., Albuquerque, NM (USA)); Mix, L.P.; Leeper, R.J.; Mehlhorn, T.A.; Maenchen, J.; Brock, E.R.; Hebron, D.E.; Johnson, D.J.; Lockner, T.R.; Nelson, W.E. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). DOE Contract AC04-76DP00789. (CONF-8905184--: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

A multi-frame ion pinhole camera has been developed to record energy-density profiles of the PFBA-II ion beam as a function of ion energy. The camera is passive and essentially insensitive to a hard x-ray dose of up to $\sim 10^5$ rads. Because the average energy of the beam ions is typically a monotonically decreasing function of time, the energy-resolved images are snapshots of the beam at different times during the PBFA-II power pulse. Beam ions that scatter from a thin gold foil are imaged, as shown, onto six separate areas of a range filter and records an image with a different lower bound on the ion energy. The images are read with VERA, a full automatic, image-processor-based nuclear track analysis system. Monte Carlo simulations have been performed to characterize the sensitivity and geometric distortion of the camera; results of these calculations, and data from recent PBFA-II shots, are presented.

4304 Storage Rings

20197 (DESY-SR-89-06) **A soft X-ray grating monochromator for undulator radiation.** Reininger, R. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.). Hamburger Synchrotronstrahlungslabor); Saile, V. Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.). Oct 1989. 19p. Available from Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.). Available from Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.).

One of the new insertion devices to be installed in the expansion of the DORIS storage ring consists of three undulators designed to cover with the first harmonic the photon energy range between 70 and 2000 eV. The concepts for a high resolution and high throughput monochromator that will take full advantage of this powerful new beam line are discussed. The final design is a modified SX-700 type monochromator in which the focusing elliptical mirror is replaced by a spherical one. The aberrations due to the new mirror are minimized by elongating the exit slit arm of the conventional SX-700. The ultimate resolution expected is 0.03 eV at 152 eV and 0.6 eV at 1086 eV with a photon flux up to 5×10^{11} photons/(sec 100 mA) at the sample. The spot size at the sample position is less than 0.4×1.0 mm^2. (orig.).

44 INSTRUMENTATION

Refer also to citation(s) 21084

4401 Radiation Instrumentation

Refer also to citation(s) 19359, 20132, 20530, 20594, 20595, 20657, 20662, 20958

20198 (BONN-IR-89-41) **Calculations on the light conduction in the light guides of the ZEUS calorimeter.** Ziegler, A. Bonn Univ. (Germany, F.R.). Physikalisches Inst.; Bonn Univ. (Germany, F.R.). Mathematisch-Naturwissenschaftliche Fakultaet. Nov 1989. 56p. (In German). Available from Bonn Univ. (Germany, F.R.). Physikalisches Inst. Available from Bonn Univ. (Germany, F.R.). Physikalisches Inst.

The sampling calorimeter of the ZEUS detector is composed of organic scintillator as detector material and depleted uranium as absorber material yielding a hadronic energy resoltuion $\sigma(E)/E = 35\%/\sqrt{E/\text{GeV}}$. The scintillator light is read out via wavelength shifters (WLS). To minimize the systematic error, the light output of the WLS must be independent of the location of the light input into the WLS. Several aspects of light propagation in the WLS have been investigated by Monte Carlo, assuming a linear model with a point light source for the WLS and simulating the WLS attenuation length with adjusted reflection coefficients over the boundary surfaces of the WLS. The inhomogeneity of the WLS light output has been investigated under various conditions: Variation of the light source position in the active part, effects of the end reflector, effects of a wedge shape in the active part, effects of different WLS-types. The results are compared with measured values. (orig.).

20199 (CBPF-NF-068/88) **An X-ray gas position sensitive detector: construction and characterization.** Barbosa, A.F. (EMBL, Grenoble (France)); Gabriel, A.; Gabriel, A.; Craievich, A. Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro, RJ (Brazil). 1988. 20p. Order Number DE90617895. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A linear x-ray gas position sensitive detector with delay line readout has been constructed. The detector is described, characterized and used for detecting x-ray diffraction patterns from polycrystals. (author).

20200 (DOE/ER/40339-3) **[Fast neutron cross section measurements]: Progress report.** Michigan Univ., Ann Arbor, MI (USA). [1990]. 57p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-87ER40339. Order Number DE90007234. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

This paper discusses the following topics: 14 MeV pulsed neutron facility; detection and measurement system; ^{238}U capture cross sections at 23 and 964 keV using photon neutron sources; capture cross sections of Au-197 at 23 and 964 keV; and yttrium nuclear cross section measurement. (LSP)

20201 (DOE/ER/40452-3) **Phonon-mediated detection of particles: Report of the round table discussion.** Sadoulet, B. (California Univ., Berkeley, CA (USA). Center for Particle Astrophysics); Cabrera, B.; Maris, H.J. Brown Univ., Providence, RI (USA). Dept. of Physics. [1989]. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-88ER40452. (CONF-890804--1: PHONON '89: 3. international conference on phonon physics and 6th international conference on phonon scattering in condensed matter, Heidelberg (Germany, F.R.), 21-25 Aug 1989). Order Number DE90006642. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Over the past five years particle physicists, nuclear physicists and astrophysicists have been increasingly interested in using phonons to detect particle interactions. In these detection attempts it is obviously critical to integrate the understanding that the phonon physicists have accumulated on the mechanisms governing the production, propagation and detection of those phonons.

Vice versa, some of the issues raised by the particle detection problem may be of significant interest and the high sensitivity methods being developed may become important for phonon physics investigations. These were the motivations for a round table discussion between members of the two communities. This report attempts to summarize the themes of a very interesting discussion. 24 refs., 2 figs., 1 tab.

20202 (EGG-WM-8774) **Real-time transuranic monitoring with a Victoreen Model 758 alpha continuous air monitor.** McIsaac, C.V.; Amaro, C.R. EG and G Idaho, Inc., Idaho Falls, ID (USA). Sep 1989. 127p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90007019. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

Data are presented on the performance of the Victoreen Model 758 alpha continuous air monitor (CAM). The solid state silicon detector installed in the Model 758 alpha CAM was calibrated using ^{239}Pu filter standards specifically prepared for this study. The calibration of the Model 758's mass flow sensor was checked using a conventional flow meter. Using the alpha CAM, ambient air was sampled overnight inside the ETRC Building at TRA and inside the RWMC Building WMF 602. Dust-laden air was generated inside a glove-box using an aerosolizer and samples of soil from the vicinity of the Rocky Flats Plant and the RWMC. This glove-box air was sampled on several occasions to determine the effect of dust loading on the response of the CAM to natural background radiation. High-mass ^{239}Pu filter standards were also prepared and analyzed to determine the effect of mass loading on the response of the detector to ^{239}Pu deposited on a sample collection filter. Two commonly used spectrum analysis techniques – the three-window method and the Los Alamos four-window method – were evaluated using alpha spectra collected during samplings of natural ambient air. 9 refs., 39 figs., 42 tabs.

20203 (KFK-4632) **Optimization of a single sphere albedo system using ^{3}He counters for the measurement of neutron dose equivalent rates and the field calibration of personnel albedo neutron dosemeters.** Al-Jarallah, M.I. Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Hauptabteilung Sicherheit. Nov 1989. 82p. Order Number DE90753601. Available from NTIS (US Sales Only), PC A05/MF A01.

The laboratory type of an active single sphere albedo dosemeter system using three ^{3}He proportional counters in a polyethylene sphere for the measurement of neutron dose equivalent rates and the field calibration of personnel neutron dosemeters was optimized with respect to the detector-moderator combination by means of calibration exposures. One detector is located in the centre of the sphere to measure the neutron dose equivalent rate and the other two detectors near the moderator surface, in order to simulate the response of the albedo neutron detector and the thermal neutron detector. The response of the detectors to neutrons in the range between thermal and 14 MeV neutrons was investigated for various moderator-absorber combinations. Comparison was made between the system response and the response of the passive detector system. After completion the active system could be used for comprehensive neutron field measurements in radiation protection. By means of a microprocessor the linear combination of the three detector readings gives energy independent readings of the neutron dose equivalent rate, the absorbed dose rate and the neutron flux density at particle accelerators and nuclear facilities. (orig./HP).

20204 (LBL-28141) **A TPC [Time Projection Chamber] detector for the study of high multiplicity heavy ion collisions.** Rai, G.; Arthur, A.; Bieser, F.; Harnden, C.W.; Jones, R.; Klienfelder, S.; Lee, K.; Matis, H.S.; Nakamura, M.; McParland, C. Lawrence Berkeley Lab., CA (USA). Jan 1990. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-900143-28: Institute for Electronic and Electrical Engineers (IEEE) nuclear science symposium, San Francisco, CA (USA), 22-26 Jan 1990). Order Number DE90007077. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The design of a Time Projection Chamber (TPC) detector with complete pad coverage is presented. The TPC will allow the measurements of high multiplicity (≈ 200 tracks) relativistic nucleus-nucleus collisions initiated with the heaviest, most energetic projectiles available at the LBL BEVALAC accelerator facility. The front end electronics, composed of over 15,000 time sampling channels, will be located on the chamber. The highly integrated, custom designed, electronics and the VME based data acquisition system are described. 10 refs., 8 figs., 1 tab.

20205 (OEFZS-4499, pp. 4-8) **Radon in dwellings: investigations and measurements.** Steger, F. (Oesterreichisches Forschungszentrum Seibersdorf G.m.b.H. (Austria)); Stadtmann, H.; Kindl, P.; Breitenhuber, L. Oesterreichisches Forschungszentrum Seibersdorf G.m.b.H. (Austria). Apr 1989. (PH-468/89;ST-165/89). In *The OENORM S 5200 'Radioactivity in building materials' as a tool for radiation protection of the general population.* Order Number DE90617643. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The inhalation of radon is an important contributor to the radiation burden for occupants of buildings. The aim of this report is to give an overview on different measuring devices for radon. Results of a pilot study and an assessment of the mean annual effective whole body dose due to inhalation of radon are given. 8 refs., 3 figs. (Author).

20206 (OEFZS-4500) **Passive integrating radondosimeter based on electret-ionization chamber.** Stadtmann, H. (Oesterreichisches Forschungszentrum Seibersdorf G.m.b.H. (Austria). Inst. fuer Strahlenschutz). Oesterreichisches Forschungszentrum Seibersdorf G.m.b.H. (Austria). Apr 1989. 80p. (In German). (ST-166/89). Order Number DE90617878. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

A passive integrating measuring system for monitoring the mean concentration of Radon (Rn222) in dwellings using an electret-ionization chamber is described. Both design and operation of the components including electret-ionization chamber, corona charging device and electret-surface voltmeter is discussed. A description of the calibration process for Radon and gammas is given. 33 refs., 4 tabs., 7 figs (Author).

20207 (PTB-Dos-18) **Dosimetry in high-energy photon fields for the calibration of measuring instruments for radiation protection purposes.** Schaeffler, D.; Kramer, H.M. Physikalisch-Technische Bundesanstalt, Braunschweig (Germany, F.R.). Dosimetrie. Aug 1989. 33p. Contract BMI St.Sch. 981. Order Number DE90753662. Available from NTIS (US Sales Only), PC A03/MF A01.

This report describes the dosimetry in various reference photon fields with energies between 4.4 MeV and about 8 MeV. Two dosimetric quantities were chosen. The air kerma was determined from measurements without a phantom and the absorbed dose to water from measurements with a phantom. This mean that the range of realization of the quantity air kerma has been extended from the energy of Co-60 photons to about 8 MeV. The results can serve as basis for the calibration of radiation protection dosemeters in nuclear power plants (0-16(n,p)N-16 reaction) with high energy photons. (orig./HP).

20208 (PTB-Ra-23) **Natural radioactive substances as activity standards.** Walz, K.F.; Schoetzig, U. Physikalisch-Technische Bundesanstalt, Braunschweig (Germany, F.R.). Radioaktivitaet. Nov 1989. 26p. (In German). Order Number DE90753663. Available from NTIS (US Sales Only), PC A03/MF A01.

A review is given of the most important data and properties of the natural radioactive substances potassium, thorium and uranium with respect to their use as radioactivity standards. (orig.).

20209 (SLAC-PUB-5123) **Construction and testing of the SLD Cerenkov Ring Imaging Detector.** Cavalli-Sforza, M. (California Univ., Santa Cruz, CA (USA). Inst. for Particle Physics); Coyle, P.; Coyne, D.; Gagnon, P.; Williams, D.A.; Zucchelli, P.; Whitaker, J.S.; Wilson, R.J.; Bean, A.; Caldwell, D. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jan 1990. 9p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract AC03-76SF00515;AT03-76ER70023. (CONF-900143-27: Institute for Electronic and Electrical Engineers (IEEE) nuclear science symposium, San Francisco, CA (USA), 22-26 Jan 1990). Order Number DE90006452. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

We report on the construction of the Cerenkov Ring Imaging Detector (CRID) for the SLD experiment at the SLAC Linear Collider and the testing of its components. We include results from testing the drift boxes, liquid radiator trays, and mirrors for the barrel CRID. We also discuss development of the support systems essential for the operation of the CRID: gas and liquid recirculator systems and monitoring. 15 refs., 9 figs.

20210 (WSRC-RP–89-359) **Third world conference on neutron radiography: Foreign trip report, May 14–23, 1989.** Salaymeh, S.R. Westinghouse Savannah River Co., Aiken, SC (USA). 6 Jun 1989. 19p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90007059. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

I attended the "Third World Conference on Neutron Radiography" and presented a paper on the "Determination of the Extent of Li-Al Alloy in Tubular Aluminum Elements by Small Source Neutron Radiology". The conference on neutron radiography is held every three years. The location of the conference is predetermined and will be rotated between the USA, Europe and Japan. The Fourth World Conference on Neutron Radiography will be held in the USA in 1992. The Third World Conference on Neutron Radiography will be held in the USA in 1992. The Third World Conference on Neutron Radiography held in Osaka, Japan was sponsored by the Atomic Energy Society of Japan, the Japanese Society for Non-Destructive Inspection and Japan Atomic Energy Research Institute. The conference was also co-sponsored by the private sector and the nuclear industry in Japan. The conference consisted of a total of 15 sessions, fourteen of which were technical. The other was an overview of the status of neutron radiography in the world presented by invited speakers from Japan, Europe and the USA. In addition to the technical presentation, five topical workshops were held and two technical tours were scheduled: The first tour was to the Research Reactor Institute, Kyoto University. The second was to Japan Atomic Energy Research Institute (JAERI), in Tokyo.

20211 **Modulation transfer function technique for real time radioscopic system characterization.** Tobin, K.W. (Oak Ridge National Laboratory, Applied Technology Division, Oak Ridge, Tennessee 37831 (USA)); Brenizer, J.S.; Mait, J.N. *Applied Optics (USA)*, 28(23): 5002-5009 (1 Dec 1989).

At the University of Virginia neutron radiography facility, a modulation transfer function technique has been developed that can easily predict and compare the resolving characteristics of the real time system and the individual system components. We desired a simple method by which new system components could be analyzed to determine their image transfer characteristics and to estimate how they would affect the composite system during data acquisition. The method employed measures a small set of constant system parameters related to data collected across a cadmium cut-edge aperture. The effects of system noise and spatial variance on the measured data are reduced so that a representation of the true signal can be obtained for analysis. Resolution parameters for the total neutron radiography system and for the individual system components are reported.

4402 Radiation Effects on Instrument Components, Instruments, or Electronic Systems

20212 (LA-UR–90-170) **Identification and solution of a charging problem in a high-altitude detector.** Berzins, G.J. (Los Alamos National Lab., NM (USA)); Valencia, J.E.; Felthauser, H.E.; Nanevicz, J.E.; Thayer, J.S. Los Alamos National Lab., NM (USA). [1989]. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-8910358–2: Spacecraft charging technology conference, Monterey, CA (USA), 31 Oct - 3 nov 1989). Order Number DE90008637. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The unwanted response of spacecraft borne instruments to electrons and other charged particles in orbit has long been at least a nuisance. In the benign case these particles generate background signals that require processing on orbit, increasing the instrument "dead time," and sometimes interfere with the measurement of small effects. In the severe extreme, electrons can charge dielectrics in or near the instrument. Such charging can be followed by a breakdown discharge that can either generate false data, or, in rare cases, cause malfunction of the instrument. In recounting how we identified and solved the problem, we would like do so from the viewpoint of experimenters who were unfamiliar with the phenomenology of spacecraft charging and unaware of the considerable work that had been done already on the subject. Such a perspective is not only descriptive, but may be potentially useful to others in similar situations. A preliminary report was presented as a poster paper at the 1986 Hardened Electronics And Radiation Technology (HEART) conference. 7 figs.

4404 Well Logging Instrumentation

Refer also to citation(s) 19349

20213 (NEI-NO–101, pp. 8) **Toolpusher logging: An aid in advanced directional drilling programs.** . Knight, O.M. (Gearhart Industries, Inc., Fort Worth, TX (USA)). Norsk Petroleumsforening, Oslo (Norway). 1983. (CONF-8310456–: 1. Northern European drilling conference, Kristiansand (Norway), 24-26 Oct 1983). In *First Northern European drilling conference, Kristiansand, Norway, October 24-26, 1983.* Order Number DE90748476. Available from NTIS (US Sales Only), PC A21/MF A01.

The paper deals with Toolpusher Looging (T.P.L.) which opens the door for quality logging information in extended reach or very high angle holes. The assurance and cost effectiveness of retrieving multi-tool logging data, on a single run under extremely difficult conditions, emphasizes the contributions of T.P.L to future drilling programs. T.P.L. components, assembly and operating technique are discussed in relation to M.W.D (Measure While Drilling) and conventional logging techniques. A synopsis of the work history of T.P. will be presented along with an analysis of problems associated with these jobs. 5 figs., 2 refs.

20214 (NEI-NO–101, pp. 18) **Remote-controlled and multi-angle bent sub.** Boulet, J.G. Norsk Petroleumsforening, Oslo (Norway). 1983. (CONF-8310456–: 1. Northern European drilling conference, Kristiansand (Norway), 24-26 Oct 1983). In *First Northern European drilling conference, Kristiansand, Norway, October 24-26, 1983.* Order Number DE90748476. Available from NTIS (US Sales Only), PC A21/MF A01.

Worldwide application of directional drilling methods are proving that drilling of the complete trajectory of a given hole size will always require changes of the bottom hole assemblies, either in rotary drilling or down hole motor drilling with fixed angle bent subs for controlling and correcting the two basic complementary directional parameters, drift angle and azimuth. In rotary drilling, accurate controls and corrections of azimuth are not possible, while methods with down hole motor and fixed angle bent subs do not permit the optimization of the drift angle for the hole profile. Therefore, the application of a down hole deviation tool adjustable from surface makes directional drilling more efficient, time saving and accurate. The paper describes the tool construction and gives the dimensional and operational data, and indicates the operating procedures and foreseen applications in directional drilling due to the very specific characteristics of this new remote-controlled tool. 6 figs., 2 tabs., 4 refs,.

4405 Thermal Instrumentation

Refer also to citation(s) 19564, 19872

20215 **A sensitive time-resolved radiation pyrometer for shock-temperature measurements above 1500 K.** Boslough, M.B. (Sandia National Laboratories, Albuquerque, New Mexico 87185 (USA)); Ahrens, T.J. *Review of Scientific Instruments (USA)*, 60(12): 3711-3716 (Dec 1989). DOE Contract AC04-76DP00789.

An optical system has been developed which can determine time-resolved temperatures in shocked materials by measuring the spectral radiance of light emitted from shocked solid samples in the visible and near-infrared wavelength range (0.5–1.0 μm). It can measure temperatures as low as 1500 K and has been successfully used to observe shock-induced chemical reactions in powder

samples. The high sensitivity of this radiation pyrometer can be attributed to the large angular aperture (0.06 sr), the large bandwidth per channel (up to 0.1 μm), the large photodiode detection areas (1.0 cm^2), and the small number of calibrated channels (4) among which light is divided. Improved calibration techniques, as well as the layout of the instrument, eliminate certain sources of error encountered in previous shock-temperature experiments. Errors in the measured spectral radiance were reduced by: (1) recalibration before every experiment to account for changes in optical components; (2) direct calibration of voltage recorded at each digitizer to prevent transfer error by an intermediate step; (3) use of a spectral irradiance calibration lamp to exclude errors due to spatial inhomogeneities associated with spectral radiance sources; and (4) obtaining a large spatial average of light at each wavelength from the same portion of the sample to eliminate errors from possible inhomogeneities in the sample. The magnitude each of these errors could previously contribute was 1%–2% of the total signal. Absolute temperature uncertainties, determined from the standard deviation of the measured spectral radiances from the least-squares-fit values, are typically about 5%. Emissivities are poorly constrained by spectral radiance data because of a weak functional dependence, and uncertainties can easily exceed 50% for temperatures of around 2000 K.

4406 Optical Instrumentation

Refer also to citation(s) 19783, 19788, 20126, 20223

20216 (EGG–10617-5009) **Study for the replacement of Kodak Royal-X Pan film.** Bunker, F.J. EG and G Energy Measurements, Inc., Los Alamos, NM (USA). Los Alamos Operations. Aug 1989. 74p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC08-88NV10617. Order Number DE90006756. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

Kodak Royal-X Pan (RXP) film has been the prime film for oscilloscope camera recording at the Nevada Test Site (NTS) since 1962. Kodak discontinued making this film in 1987, however, so it became necessary to find a substitute that had as many of the photographic characteristics of RXP as possible — spectral sensitivity, image quality, recording speed, base plus fog background density, and processing parameters. (RXP and Kodak 857 developer will continue being used at NTS until the film supply is exhausted.) RXP $2\frac{1}{4} \times 3\frac{1}{4}$-inch film has been the film of choice for oscillography at NTS because of its sensitivity to the blue radiation from P-11 phosphor, which constitutes the coating of oscilloscope tubes, and its ability to record fast transient occurrences, such as oscilloscope traces, in or near nanosecond exposure times. 1 ref., 40 figs., 4 tabs.

20217 (LBL–25959) **Mirror figure control primitives for the Keck Observatory ten meter primary mirror.** Meng, J.D.; Minor, R.; Merrick, T. Lawrence Berkeley Lab., CA (USA). Sep 1989. 8p. DOE Contract AC03-76SF00098. (CONF-890374–2: SPIE technical symposium on aerospace sensing, Orlando, FL (USA), 27-31 Mar 1989). Order Number DE90007068. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Keck Observatory primary mirror is comprised of 36 segments from which 216 glass temperatures and 168 measures of relative displacement are continuously read. Mirror figure adjustments are under the active control of 108 adjustable-length actuators, three per segment. We describe our collection method for mirror segment displacement data and glass temperature data and the supplying of individual control signals to the actuator controllers and sensor electronics, both located near each mirror segment, and discuss the mirror's computerized control system. Much of the sense and control electronics is close to the rear surface of the primary mirror. From an historical perspective, we describe the impact of the need to minimize heat sources and cabling, on the communications method used and on its implementation. We conclude with a brief structural overview of the hardware in use to actively maintain primary mirror figure. 4 refs., 5 figs., 1 tab.

20218 (LBL–25960) **Position control of the mirror figure control actuator for the Keck Observatory ten meter primary mirror.** Meng, J.D.; Minor, R.; Merrick, T.; Gabor, G. Lawrence Berkeley Lab., CA (USA). Sep 1989. 9p. Sponsored by California Institute of Technology; U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-890374–3: SPIE technical symposium on aerospace sensing, Orlando, FL (USA), 27-31 Mar 1989). Order Number DE90006981. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Each of the 108 hydraulic actuators on the Keck ten meter primary mirror lengthens or shortens under electronic control in steps of about four nanometers. The starts and stops of longer moves are profiled to help prevent the stimulation of mirror system mechanical resonances by abrupt actuator length changes. At the move endpoint, the actuator is kept still to prevent the pumping of periodic energy into these resonances. Endpoint stiffness is maintained by electronic feedback. The combined power dissipation of the actuator and its local control system is constrained by the need to minimize heat generation in the vicinity of the mirror. In this paper, we discuss observed stictional and other mechanical phenomena associated with a very short bi-directional actuator length changes and trace the impact of the various constraints on actuator controller design and implementation. We present some results of tests with an actuator controller driving an actuator which in turn drives a displacement sensor. The units under test are production devices to be used in the Keck primary mirror active figure control. 2 refs., 6 figs.

20219 **A fast UV/visible pyrometer for shock temperature measurements to 20 000 K.** Radousky, H.B. (Lawrence Livermore National Laboratory, Livermore, California 94550 (US)); Mitchell, A.C. *Review of Scientific Instruments (USA)*, 60(12): 3707-3710 (Dec 1989). DOE Contract W-7405-ENG-48.

An ultraviolet/visible pyrometer is described which can measure shock temperatures from 3000 to 20 000 K. The system is modular, and in general consists of six photomultiplier tubes and two linear intensified diode array/spectrograph systems which can cover the range from 250 to 800 nm. Extension of the pyrometer's capabilities into the ultraviolet is necessary for accurate measurements above 8000 K. The nature of the shock environment requires the photomultiplier tubes to have rise times on the order of 2 ns, with a typical experiment lasting between 20 and 500 ns. The system measures absolute intensity, and is calibrated against a known tungsten lamp prior to each experiment. The highest temperature measured was 18 300 K for fluid Xe. The targets needed to contain this type of cryogenic sample are described as well.

20220 **Comment on "VISAR analysis in the presence of large intensity changes: Application to the expanding ring" [Rev. Sci. Instrum. 60, 754 (1989)].** Hemsing, W. (Los Alamos National Laboratory, University of California, Mail Stop P942, Los Alamos, New Mexico 87545 (US)). *Review of Scientific Instruments (USA)*, 60(12): 3832-3833 (Dec 1989).

A published method to salvage VISAR data that is imperfect, due to variations of light intensity, is necessary only when the instrument has not been properly set up. Normally corrections for changing intensity are made automatically.

20221 **Reply to "Comment on 'VISAR analysis in the presence of large intensity changes: Application to the expanding ring' " [Rev. Sci. Instrum. 60, 3832 (1989)].** Gourdin, W.H. (Lawrence Livermore National Laboratory, Materials Division, Chemistry and Materials Science Department, L369, P.O. Box 808, Livermore, California 94551 (US)). *Review of Scientific Instruments (USA)*, 60(12): 3833-3834 (Dec 1989).

The published method to correct VISAR data is applicable to those cases in which an existing instrument would require radical modification in order to eliminate the behavior addressed in the original article.

4408 Miscellaneous Instrumentation

Refer also to citation(s) 19305, 19491, 20139, 20249, 20530, 20648, 20841

20222 (BNL–42934) **Biomedical applications of synchrotron x-ray microscopy.** Jones, K.W.; Bockman, R.S.; Gordon, B.M.; Rivers, M.L.; Saubermann, A.J.; Schidlovsky, G.;

Spanne, P. Brookhaven National Lab., Upton, NY (USA). Oct 1989. 13p. Sponsored by U.S. DOE Energy Research; U.S. Department of Health and Human Services; Swedish Medical Research Council; Swedish Society of Medicine. DOE Contract AC02-76CH00016. P41RR01838;CA3845;CA29502;MFR-7557. (CONF-8906283–1: 2. international workshop of X-ray fluorescence (XRF) and PIXE applications in life sciences, Capri (Italy), 29-30 Jun 1989). Order Number DE90004957. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

X-ray beams produced in synchrotron storage rings are useful for many biomedical experiments since a very high flux of x rays can be delivered to a sample. The beam can be restricted to a diameter of less than 10 micrometers using appropriate optical systems or collimators. It is then possible to employ these beams to make elemental maps of biological materials using synchrotron radiation-induced x-ray emission (SRIXE) to identify particular elements or to use differences in the linear attenuation coefficients for computed microtomography (CMT). Biomedical applications of these methods will be illustrated using work done at the Brookhaven X-26 X-Ray Microscope.

20223 (DOE/ID/12557–3) **Case study for a high temperature ultraviolet absorption hygrometer.** Gersh, M.E. (EG and G Idaho, Inc., Idaho Falls, ID (USA)); Bangert, M.; Matthew, M.W.; Lowe, R. Spectral Sciences, Inc., Burlington, MA (USA); Pacer Systems, Inc., Billerica, MA (USA). Oct 1989. 43p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FC07-85ID12557. Order Number DE90007358. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The motivation for this program is the observation that the use of reliable and accurate hygrometers to monitor or control the processes in industrial drying chambers could result in a significant reduction in the energy usage of the United States. At the present time, there are no commercially available hygrometers which have the required characteristics of a measurement capability at simultaneously high temperature and humidity, along with the ability to operate for long periods in a severely contaminating and/or particle-laden environment. The goal of this program was the development of an industrial hygrometer which can be employed to monitor the humidity during industrial drying operations. This requires a device which can operate at temperatures up to 500°C, at high humidity (50–100%), and in environments containing particulates and/or fouling or corrosive vapors. The approach taken by Spectral Sciences, Inc. (SSI) for the development of a practical hygrometer for these operational conditions is the use of the differential absorption of light by water vapor. Light absorbed at two ultraviolet (UV) wavelengths determines the absolute humidity (measurement of temperature by conventional means also permits the determination of relative humidity). Due to the use of this principle to measure the humidity, we have termed this instrument an Ultraviolet Absorption Hygrometer (UVAH). 11 figs.

20224 (SAND–89-1980C) **Finite element analysis of a quartz rotation sensor.** Lobitz, D.W.; Marek, E.L.; Reese, G.M. Sandia National Labs., Albuquerque, NM (USA). [1989]. 16p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9004116–2: AIAA/ASME SDM conference, Long Beach, CA (USA), 2-4 Apr 1990). Order Number DE90006959. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A finite element study in support of the design of a quartz crystal resonator for use as a rotation sensor is presented. This work is the first three dimensional analysis of such a resonator. Rotation is sensed by measuring the coupling induced by Coriolis forces between two orthogonal shear modes. These shear modes are measured and excited through the piezoelectric effect. They consist of low-order shear motions coupled to high-order flexure. A highly refined mesh is required to accurately capture this behavior. The design is driven by the need to geometrically tune the sensor such that the two shear modes coincide in frequency. Finite element modeling proved to be indispensible in achieving this design goal. Experimental results from parts fabricated in accordance with the final design indicate that the measured and predicted modal frequencies agree with less than 1% error. The desired shear modes, which are greater than the 200th mode in the spectrum, are carefully classified using a straight-forward procedure which gives the effective piezoelectric coupling to specific electrode geometries. A description of the evolution of the finite element model is given along with various obstacles that were overcome during the course of the analysis. 9 refs., 9 figs.

20225 (SFB-210/A–42, pp. 227-242) **Adaptation of digital data collection systems to flow mechanics experiments.** Ermshaus, R.; Scharna, H. Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke. Mar 1988. (In German). In *Work and result report of Special Research Area 210 for the years 1985-1987.* Available from Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke. Available from Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke.

As a 'service project', the part project E2 provides hardware and general software for all the projects in SFB 210, which can only carry out research using digital and processing methods. Because of the complexity of the computer plant available for SFB 210, integration of the tasks of E2 in the research part projects which mainly use the plant, is unsuitable and can hardly be achieved. The aim of the part project E2 is to create the conditions for carrying out the EDP tasks necessary in SFB 210 as efficiently as possible. The configuration of the EDP system is introduced. (orig./KW).

20226 (UCID–21835) **Single antenna interferometry.** Fitch, J.P. Lawrence Livermore National Lab., CA (USA). 16 Dec 1989. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008120. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Interferometry from air and space borne platforms which require synthetic aperture radar image synthesis has been demonstrated in earlier experiments by using either two physical antennas mounted on one airframe or two passes of the same antenna over the same scene. In this paper, one pass of a single antenna radar system with a high pulse repetition frequency is used to form an interferometric image which, under initial investigation, appears to be sensitive to ocean surface effects due to ship-generated internal waves. 5 refs., 4 figs., 1 tab.

20227 **Polarization characteristics of wire mesh at 119.** Hwang, Y.S. (Princeton University, Plasma Physics Laboratory, P.O. Box 451, Princeton, New Jersey 08543 (US)); Park, H.K. *Applied Optics (USA),* 28(23): 4999-5001 (1 Dec 1989).

Polarization characteristics of the transmitted beam through the various sizes of metal wire grid meshes are examined experimentally at 118.8 μm. When these results were compared to Chen's waveguide theory, we obtained excellent agreement. In particular, when the incident beam polarization is neither parallel (TM) nor perpendicular (TE) to the wire grid axis, a linearly polarized incident beam can be made elliptic due to the phase difference between the TE and TM modes.

45 MILITARY TECHNOLOGY, WEAPONRY, AND NATIONAL DEFENSE

Refer also to citation(s) 19254, 19791, 19792

20228 (K/DSRD–114) **The constraint model of attrition.** Hartley, D.S. III. Oak Ridge Gaseous Diffusion Plant, TN (USA). [1989]. 8p. Sponsored by U.S. Department of Defense. DOE Contract AC05-84OR21400. (CONF-891275–1: 1989 Winter simulation conference, Washington, DC (USA), 4-6 Dec 1989). Order Number DE90007108. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Helmbold demonstrated a relationship between a ratio containing initial force sizes and casualties, herein called the Helmbold ratio, and the initial force ratio in a large number of historical battles. This paper examines some of the complexity of the Helmbold ratio using analytical and simulation techniques and demonstrates that a constraint model of attrition captures some aspects of historical data. The effect that the constraint model would have on warfare

modeling is uncertain. However, some speculation has been attempted concerning its use in large scale simulations. 9 refs., 7 figs., 2 tabs.

20229 (K/DSRD–117) **Verification and validation of SIMNET-T.** Hartley, D.S. III.; Quillinan, J.D.; Kruse, K.L. Oak Ridge Gaseous Diffusion Plant, TN (USA). [1989]. 25p. Sponsored by U.S. Department of Defense. DOE Contract AC05-84OT21400. (CONF-8906256–2: 57. military operations research symposium, Fort Leavenworth, KS (USA), 6-8 Jun 1989). Order Number DE90007110. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The verification and validation (V&V) of a portion of the SIMNET-T system is producing several benefits. The V&V process itself has provided the impetus to the system designer to make needed changes to the model. Also, knowledge of the direction and magnitude of tgh error terms in the SIMNET approximations provides a basis for evaluating impacts on the training and development missions. More importantly, the SIMNET V&V will be the basis for making the follow-on Close Combat Tactical Trainer (CCTT) system a better system. Finally, the SIMNET V&V is providing a model for the Army's Verification and Validation program. 14 refs., 11 figs.

20230 (K/DSRD–119) **Report of the first annual airborne weapons training technology review.** Snyder, C.E. (Oak Ridge Gaseous Diffusion Plant, TN (USA)); Payne, G.B.; Treitler, I.E. Oak Ridge Gaseous Diffusion Plant, TN (USA). Jan 1990. 56p. Sponsored by U.S. Department of Defense. DOE Contract AC05-84OT21400. Order Number DE90007189. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This report documents the First Annual Airborne Weapons Training Technology Review. The Review was held at Oak Ridge Associated Universities from March 29 to 31, 1989. It was an exchange of ideas and information among the members of the network supporting the Naval Air Systems Command's (NAVAIR's) PMA205-11, Program Manager for Ordnance Training. This report describes the briefings and demonstrations presented at the Review, and summarizes the discussion at the informal caucus where significant issues were raised from the first two days' presentations. The report also contains the meeting agenda, a participant list with addresses and telephone numbers, a list of the Department of Defense activities represented, NAVAIR's follow-up communication, and a brief description of Martin Marietta Energy Systems, Inc.'s training technology project support. A broad range of topics related to training systems and training support was covered during the Review. Synopses of the presentations and demonstrations included here cover computer-based and interactive systems, portability of software, reuse of training systems for different weapons, standardization of trainers, instructional systems design, cognitive task analysis, tracking of training resources, and the application of Computer-aided Acquisition and Logistic Support.

20231 (LA–11750-MS) **The Soviet Union: Political and military trends.** Pilat, J.F.; Garrity, P.J. Los Alamos National Lab., NM (USA). Jan 1990. 15p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. Order Number DE90006476. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

CNSS Occasional Papers No. 23.

On July 20, 1989, the Center for National Security Studies (CNSS) of the Los Alamos National Laboratory held a workshop on "The Soviet Union: Political and Military Trends." The morning session was devoted to a discussion of the magnitude of the problems confronting the Soviet Union, the political and economic reforms designed to address those problems, and the repercussions of those reforms on Soviet foreign policy and defense spending. In the afternoon session, the Soviet view of the changing character of warfare, the technologies and force structures that the Soviets might develop and deploy to anticipate the battlefield of the future, and the role that conventional arms control might play in Soviet political and military strategy were examined.

20232 (ORNL/DSRD/TM–46) **ORGAME: A fast interactive model for contingency analysis.** Smith, O.L. Oak Ridge National Lab., TN (USA). Dec 1989. 94p. Sponsored by U.S. Department of Defense. DOE Contract AC05-84OR21400. Order Number DE90006432. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

A fast interactive computer simulation model for contingency analysis is developed. The analysis begins with formulation of a mathematical framework that defines confrontation at the task force and weapons level. Interaction is quantified in terms of the basic combat processes of detection, rate of fire, firing accuracy, and weapon lethality. For situations in which the data required by this level of detail are lacking, an alternative pairwise comparison input methodology is permitted. Both ground and air units are treated. The front line of own troops (FLOT) is used as a measure of effectiveness and is determined by an eigenvalue calculation of the relative values of weapons on each side of the engagement. High-resolution graphics continuously provide mapping and battle progress information. Convenient user interaction during a run permits quick and easy investigation of a wide range of force structure and tactical alternatives. An automated sensitivity analysis graphically identifies all of the most important parameters in the simulation. In addition to the deterministic mode of operation, the model provides a Monte Carlo stochastic analysis that demonstrates the impact of the uncertainties in the input parameters on battle outcome. 1 ref., 13 figs., 22 tabs.

20233 (ORNL/TM–11024) **Automated support for processing special assignment airlift missions (SAAMs): A concept paper.** Sexton, A.; Hwang, Ho-Ling. Oak Ridge National Lab., TN (USA). 30 Oct 1989. 32p. Sponsored by U.S. Department of Defense. DOE Contract AC05-84OR21400. Order Number DE90006429. Available from NTIS, PC A03/MF A01 - OSTI.

The Airlift Development Analysis System (ADANS) is a research and development effort sponsored by the Headquarters, Military Airlift Command (HQ MAC) and conducted by researchers at Oak Ridge National Laboratory (ORNL). The purpose of this effort is to upgrade HQ MAC's automated capabilities for scheduling peacetime/wartime missions, deliberate and execution planning, and analysis of the airlift system. HQ MAC is also integrating its airlift scheduling processes to provide an easier transition from peacetime to wartime duties. The goal of this research and development effort is to provide an integrated system that allows HQ MAC to better maintain its forces in a constant state of readiness. The development for ADANS is scheduled in three increments and is to be completed in September 1992. This paper documents the procedures for processing SAAMs at HQ MAC as of May 1989 and presents functions that will be provided by ADANS to support SAAMs. In general, ADANS will provide HQ MAC Current Operations, Airlift Management Division, Special Airlift Branch (HQ MAC/DOOMS) and Air Transportation, Director of Cargo and Requirements, Special Assignment Airlift Division (HQ MAC/TRKS) with the ability to automate SAAM information management/data processing tasks, along with systematic error and consistency checking. Reports will be generated automatically by the system for analysis of SAAM requirements and airlift allocation. Consequently, better data integrity among various forms and reports can be expected.

4501 Chemical Explosions and Explosives

20234 (LA-UR–90-255) **A program of fundamental research on explosives at Los Alamos.** Rivera, T. Los Alamos National Lab., NM (USA). 1990. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-900394–1: 1990 national symposium of the Society of Mexican-American Engineers and Scientists (MAES), Albuquerque, NM (USA), 28-31 Mar 1990). Order Number DE90006509. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Fundamental Research on Explosives (FRE) program was initiated as a five-year program beginning in FY 1982. It was established as a Laboratory-wide coordinated theoretical and experimental effort to gain a fundamental understanding of detonation behavior using state-of-the-art techniques not previously applied to explosives. During the five years a variety of significant scientific achievements was made in both theory and experiment by developing new methods and techniques to study equation-of-state (EOS), shock initiation, and detonation phenomena. The FRE program comprised scientific experimental and theoretical investigations into the chemical and mechanical processes leading to and

subsequently sustaining detonation of the simple liquid prototypical explosive, nitric oxide (NO). The goals of the FRE program were to understand the energetics and chemistry of initiation and detonation in liquid NO and to compare experimental results with existing theory. The knowledge gained and the techniques developed have led not only to advances in explosives science but in the theoretical and experimental sciences in general. This report is a brief overview of the FRE achievements during the 5 year program.

4502 Nuclear Explosions and Explosives

Refer also to citation(s) 20263

20235 (AD-A-214199/2/XAB) **Technology of fast spark gaps. Final report, October 1987-July 1988.** Standler, R.B. Pennsylvania State Univ., University Park, PA (USA). Communications and Space Sciences Lab. Sep 1989. 45p. Available from NTIS, PC A03/MF A01.

To protect electronic systems from the effects of electromagnetic pulses (EMP) from nuclear weapons and high-power microwave (HPM) weapons, it is desirable to have fast-responding protection components. The gas-filled spark gap appears to be an attractive protection component, except that it can be slow to conduct under certain conditions. This report reviews the literature and presents ideas for construction of a spark gap that will conduct in less than one nanosecond. The key concept to making a fast-responding spark gap is to produce a large number of free electrons quickly. Seven different mechanisms for production of free electrons are reviewed, and several that are relevant to miniature spark gaps for protective applications are discussed in detail. These mechanisms include: inclusion of radioactive materials, photoelectric effect, secondary electrode emission from the anode, and field emission from the cathode.

20236 (SAND–89-1971) **Certification of ANVIL 5000 mass properties: ANVIL 5000 Version 1.2, Simple homogeneous shapes and point-mass assemblies.** Robison, R.H. Sandia National Labs., Albuquerque, NM (USA). Oct 1989. 27p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90006464. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This document evaluates the accuracy of mass properties computations from the ANVIL 5000 CAD system. Mass property results and a measure of their accuracy are given for both individual solid model components and for point-mass assembly sums. The mass properties' accuracies were determined by comparing the results obtained from ANVIL 5000 with either theoretical values or with results from another trusted software package.

20237 (SAND–89-3051) **Simulation fidelity in lightning penetration studies.** Fisher, R.J. (Sandia National Labs., Albuquerque, NM (USA)). Sandia National Labs., Albuquerque, NM (USA). Feb 1990. 33p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90006367. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

An extensive literature review has been conducted as part of an effort to quantify the fidelity of Sandia's lightning burn-through simulation technique. The dominant parameters affecting damage have been identified and are discussed. Two alternative techniques for qualitatively improving the Sandia simulation have been identified, but quantification of the correlation of the results of each with those of natural lightning awaits completion of further experimental work. A systematic set of laboratory experiments is proposed to assess the sensitivity of each technique to key simulation parameters. An available calibration linkage to natural lightning is the reproduction of damage spots that were created by lightning on a set of copper disks mounted on TV towers, and an attempt to do this is included in the proposed experiments. In order to reduce the uncertainties of this approach, more lightning-spot data are required, along with records of the flash currents that produced them. It is recommended that such data be acquired in conjunction with the Rocket-Triggered Lightning Program being conducted each summer at the Kennedy Space Center. 25 refs., 5 figs., 1 tab.

20238 (SAND–89-3073) **Hybrid thin-slot algorithm for the analysis of narrow apertures in finite-difference time-domain calculations.** Riley, D.J.; Turner, C.D. Sandia National Labs., Albuquerque, NM (USA). Jan 1990. 41p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90005823. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The modeling of apertures that are narrow with respect to the spatial cell size is a well-known problem for finite-difference time-domain (FDTD) electromagnetic codes. Although the possibility of using "half-space" transient integral equations to characterize narrow apertures in FDTD codes has been suggested and studied by others, a solution to the fundamental problem of how the two techniques could be combined so that full coupling to the aperture is accounted for was unknown. A scheme which resolves this problem is presented here. To introduce the technique, only linear apertures that are electrically narrow with regard to both their width and depth are discussed, but extensions to more complex aperture configurations should be possible. The method incorporates an independent "time-marching" solution for the aperture problem into the FDTD code, and therefore, the burden of gridding the aperture by a general-purpose FDTD code is avoided. A feedback scheme is used so that full exterior and interior coupling is included in the aperture solution. This "hybrid thin-slot algorithm" (HTSA) is quite easy to implement, yields high accuracy, and gives rise to a "one-step" FDTD solution. 15 refs., 13 figs.

20239 (UCID–21199) **Final safety analysis report for the Hardened Engineering Test Building (HETB).** Odell, B.N.; Halinan, E.J. Lawrence Livermore National Lab., CA (USA). Oct 1988. 130p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90006327. Available from NTIS, PC A07/MF A01 - OSTI.

This Safety Analysis Report (SAR) for the Lawrence Livermore National Laboratory (LLNL) Hardened Engineering Test Building (HETB, Building 334) provides the necessary information and analyses to conclude that the facility can be operated without endangering the safety of operating personnel or the public or adversely affecting environmental quality. This chapter provides a basic overview of the scope of the SAR and summarizes the facility design and processes, while Chapter 2 summarizes the safety analyses performed. Subsequent chapters discuss the following: The LLNL site, facility location, and environmental factors are described in Chapter 3; the facility and operation are described in Chapter 4; health protection, including safety systems and environmental safety, are provided in Chapter 5; hazards and accidents are analyzed in Chapter 6; the conduct of operations, covering both organizational structures and operational safety requirements, is discussed in Chapter 7; quality assurance is described in Chapter 8. Appendices contain detailed analytical information on selected topics. References are listed sequentially at the end of each chapter; to preclude excessive entries, common government agency references (e.g., DOE Orders) are not listed.

4503 Nuclear Explosion Detection

20240 **Planar array bearing estimation performance bounds.** Harris, D.B. (Lawrence Livermore National Lab. (US)). pp. 994 of Proceedings of the twenty-first Asilomar conference on signals, systems and computers. Chen, R.R. IEEE Service Center, Piscataway, NJ (1988). DOE Contract W-7405-ENG-48. (CONF-871162–: 21. annual Asilomar conference on signals, systems, and computers, Pacific Grove, CA (USA), 2-4 Nov 1987).

In this paper, the Weiss-Weinstein bound on bearing estimator mse is evaluated for planar arrays possessing near-circular symmetry and simpler triaxial single-station instruments. The bounds suggest superior bearing estimation performance for small-aperture seismic arrays when contrasted with the simpler instruments, particularly in the threshold SNR region. The results have implications for the composition of a seismic network that might be deployed to verify nuclear test ban treaties.

4504 Nuclear and Radiological Warfare

20241 (AD-A–214137/2/XAB) **Design of a bounded-wave EMP (Electromagnetic Pulse) simulator (intended as second-stage simulator for DREO (Defence Research Establishment Ottawa)).** Sevat, PP.A. Defence Research Establishment, Ottawa, ON (Canada). Jun 1989. 106p. (DREO–1006). Available from NTIS, PC A06/MF A01.

Electromagnetic Pulse (EMP) simulators are used to simulate the EMP generated by a nuclear weapon and to harden equipment against the effects of EMP. At present, DREO has a 1-m EMP simulator for testing computer-terminal-size equipment. To develop the R&D capability for testing larger objects, such as a helicopter, a much bigger threat level facility is required. This report concerns the design of a bounded wave EMP simulator suitable for testing large size equipment. Different types of simulators are described and their pros and cons are discussed. A bounded-wave parallel-plate-type simulator is chosen for its efficiency and the least environmental impact. Detailed designs are given for 6-m and 10-m parallel-plate-type wire-grid simulators. Electromagnetic fields inside and outside the simulators are computed. Preliminary specifications for a pulse generator required for the simulator are also given. Finally, the electromagnetic fields radiated from the simulator are computed and discussed.

20242 (AD-A–214453/3/XAB) **Proposed activities to prepare for testing advanced/Stealth weapons systems. Technical publication, August-September 1989.** Bishop, H.T. Air Force Weapons Lab., Kirtland AFB, NM (USA). Aug 1989. 21p. (WL/NTA-TP–89-001). Available from NTIS, PC A03/MF A01.

The B-2 brings new challenges for Electromagnetic Pulse (EMP) Testing. This paper discusses the unique characteristics of the B-2 and develops a time line of activities that need to be completed by the AF Weapons Laboratory before EMP testing of the B-2 begins.

4505 Strategic Defense Initiative

Refer also to citation(s) 20212, 20622

20243 (AD-A–214020/0/XAB) **Space-Based Interceptor (SBI), environmental assessment. Final report.** Brown, G. Strategic Defense Initiative Organization, Washington, DC (USA). Systems Engineering. Aug 1987. 82p. Available from NTIS, PC A05/MF A01.

The Strategic Defense Initiative Organization and its proponents plan to conduct Demonstration/Validation tests of the SBI technology. These tests will demonstrate the ability of the technology to perform the required tasks, and validate a future decision on whether to proceed with Full-Scale Development. Demonstration/Validation tests would be conducted at Eglin Air Force Base, Edwards Air Force Base, U.S. Army Kwajalein Atoll, National Test Facility, and contractor facilities. Tests would include analyses, simulations, component/assembly tests, and flight tests. This document addresses the potential environmental consequences of the Demonstration/Validation testing of the SBI technology.

20244 (AD-A–214033/3/XAB) **Boost Surveillance and Tracking System (BSTS): Environmental assessment. Final report.** Brown, G. Strategic Defense Initiative Organization, Washington, DC (USA). Systems Engineering. Aug 1987. 56p. Available from NTIS, PC A04/MF A01.

The Strategic Defense Initiative Organization and its proponents plan to conduct Demonstration/Validation tests of the BSTS technology. These tests will demonstrate the ability of the technology to perform required tasks, and will validate a future decision on whether to proceed with Full-Scale Development. Demonstration/Validation tests would be conducted at the National Test Facility, Cape Canaveral Air Force Station/Eastern Test Range, and at contractor facilities. Test would include analyses, simulations, component/assembly tests, and flight tests. This document addresses the potential environmental consequences of the Demonstration/Validation testing of the BSTS technology.

20245 (AD-A–214055/6/XAB) **Strategic Defense Initiative Demonstration/Validation Program: Environmental assessments summary. Final report.** Brown, G. Strategic Defense Initiative Organization, Washington, DC (USA). Aug 1987. 131p. Available from NTIS, PC A07/MF A01.

The Strategic Defense Initiative Organization and its proponents plan to conduct Demonstration/Validation tests of the six technologies to demonstrate their respective ability to perform their required tasks, and to validate the requirements to determine their feasibility for a future decision on whether to proceed with full-scale development. Demonstration/Validation tests would be conducted at 14 government facilities across the United States and the Republic of the Marshall Islands, and at contractor facilities. Tests would include analyses, simulations, component/assembly tests, and flight tests. This document summarizes the findings expressed in the six environmental assessments for Demonstration/Validation testing of the individual technologies, and analyzes the potential cumulative environmental consequences of testing of multiple technologies at a given facility.

20246 (AD-A–214139/8/XAB) **Proposed actions at US Army Kwajalein atoll. Final environmental impact statement (FEIS).** Army Strategic Defense Command, Huntsville, AL (USA). Oct 1989. 196p. Available from NTIS, PC A09/MF A02.

The purpose of the Proposed Action is to conduct tests and collect data in support of continuing research, development, and operational missions; operational space track missions; and Strategic Defense Initiative research, development, test, and evaluation activities. Three alternatives are considered in the Environmental Impact Statement (EIS). The No-Action Alternative includes the ongoing activities at USAKA. The Proposed Action includes installation and testing of SDI sensing/tracking equipment and interceptor missile systems. Four construction projects in support of base operators are also included. Finally, the EIS examines a Change of Duration Alternative that implement as the Proposed Action over a longer period of time. The EIS examines the environmental impacts of each alternative. Where impacts were found to be potentially significant, mitigation measures are identified. Key topics addressed by the EIS include land and reef areas, water resources, air quality, noise, biological resources including endangered species, cultural resources, socioeconomics, transportation, utilities, electromagnetic radiation from radars, and range safety.

20247 (AD-A–214150/5/XAB) **Kiernan reentry measurements system on Kwajalein atoll.** Roth, K.R.; Austin, M.E.; Frediani, D.J.; Knittel, G.H.; Mrstik, A.V. Massachusetts Inst. of Tech., Lexington, MA (USA). Lincoln Lab. 1989. 30p. (JA–6340). Available from NTIS, PC A03/MF A01.

Pub. in Lincoln Laboratory Jnl., Vol. 2, No. 2, 247-276 1989. Original contains color plates: All DTIC/NTIS reproductions will be in black and white.

The Kiernan Reentry Measurements System (KREMS), located on Kwajalein Atoll in the Pacific, is the United States' most sophisticated and important research and development radar site. Consisting of four one-of-a-kind instrumentation radars, KREMS has played a major role for the past 25 years in the collection of data associated with ICBM testing. Furthermore, it has served as an important space-surveillance facility that provides an early U.S. view of many Soviet and Chinese satellite launches. Finally, the system is slated to play a key role in Strategic Defense Initiative experiments.

20248 (AD-A–214243/8/XAB) **High-resolution imaging by phase retrieval and discrimination using speckle. Volume 1. Final report, August 1987-January 1989.** Environmental Research Inst. of Michigan, Ann Arbor, MI (USA). Mar 1989. 132p. (ERIM–201600-11-F-VOL-1). Available from NTIS, PC A07/MF A01.

Concepts for unconventional sensors capable of high-resolution imaging and parameter estimation for the SDI midcourse discrimination application were developed. The basic sensor consists of a large filled array of small-aperture receivers that measure a laser-illuminated object's Fourier intensity in the aperture of the receiver. Reconstruction of a high-resolution image using a phase-retrieval algorithm was investigated via theoretical analysis, computer simulations, and laboratory experiments. In particular, modification of the basic sensor to include a small-aperture, diffraction-limited imager within the array was studied. A method was developed to use the additional low-resolution image data in the process of reconstructing a high-resolution image. This method first retrieves the

Fourier phase over the small aperture of the low resolution imager using the Gerchberg-Saxton algorithm and then proceeds with phase retrieval over the entire array aperture using the iterative Fourier-transform algorithm. This method was successfully demonstrated via computer simulations. Reconstruction of the image of a simple two-part object from Fourier intensity data gathered in a laboratory experiment was also achieved. Non-imaging, speckle correlation methods were developed that use the data provided by the large array of receivers to measure rotation rates and separation rates for multiple objects.

20249 (LA-UR–90-296) **BEAR electrostatic analyzer: Flight results.** Anerson, H.R. (Science Applications International Corp., Bellevue, WA (USA)); Potter, D.W.; Morse, D.L.; Olson, J.R.; Johnson, J.L.; Pongratz, M. Los Alamos National Lab., NM (USA). 3 Jan 1990. 8p. Sponsored by National Aeronautics and Space Administration. DOE Contract W-7405-ENG-36. (CONF-8910358–1: Spacecraft charging technology conference, Monterey, CA (USA), 31 Oct - 3 nov 1989). Order Number DE90006511. Available from NTIS, PC A02/MF A01 - OSTI.

The Electrostatic Analyzer (ESA) measured the intensity of charged particles returning to the BEAR payload during flight on 13 July 1989. These particles form part or all of the current that returns to the payload to neutralize the charge ejected with the beam. By measuring the return flux with high time resolution, we can study the physics of charging processes. When the neutralizer was off, the payload emitted 10 mA negative and charged to several hundred volts with a maximum of~800V. With the neutralizer on (normal configuration) the payload emitted ~ 1mA negative and received electrons with energies up to a few hundred volts in some attitudes. This suggests charging to a few hundred volts. The charging rate of the payload is consistent with the rocket body capacitance with respect to a vacuum. 1 ref., 14 figs.

20250 (LA-UR–90-456) **An electrical model for plasma armature voltage.** Parker, J.V. Los Alamos National Lab., NM (USA). [1990]. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-9004136–2: 5. IEEE symposium on electromagnetic launch technology, Destin, FL (USA), 1-5 Apr 1990). Order Number DE90007530. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Scaling of armature voltage with bore diameter is an important issue since it affects the predicted efficiency and the predicted velocity performance of proposed large-bore EM launchers. In this paper the experimental data for railguns with plastic/composite insulation is shown to fit a scaling relation of the form $V_m = V_e + E(j)d$, where the electric field dependence on current density is given by $E(j) = E_0 + J/\sigma$. This scaling relation predicts a linear increase in armature voltage with bore diameter for $d > 0.1$ m. The model is in better agreement with the limited data on large bore railguns than earlier models. 21 refs., 5 figs., 1 tab.

20251 (SAND–90-0092C) **Three-dimensional structural analyses of reentry vehicles.** Gwinn, K.W. Sandia National Labs., Albuquerque, NM (USA). [1990]. 15p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9004116–1: AIAA/ASME SDM conference, Long Beach, CA (USA), 2-4 Apr 1990). Order Number DE90006278. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The three-dimensional structural analysis of reentry vehicles presents a considerable challenge to the analyst. This is due to the mechanics of the problem as well as the incorporation of results from several disciplines into the environmental description of the problem. Separate results from aero-analyses, frequently computed in one-dimensional form, must be combined into a three-dimensional format suitable for a structural finite element analysis. Features required for the analysis include the ablated thickness of the heatshield structure, as well as pressure on the vehicle and the temperature distribution through the heatshield. By combining these environments, a complete description of all factors which affect the structural performance of reentry vehicles are included into one analysis. This paper presents a method of analyzing the structural response of reentry vehicles using the complete three-dimensional environmental load description. In addition, this method permits the timely completion of such analyses on a production basis without making assumptions or simplifying the loading environments involved. Results from an analysis are presented which illustrate this method. The analysis uses a composite material description of the aeroshell along with temperature dependent properties. 2 refs., 7 figs.

20252 (UCRL–102653) **Effect of a random wind field on thermal blooming instabilities.** Morris, J.R.; Viecelli, J.A.; Karr, T.J. Lawrence Livermore National Lab., CA (USA). Jan 1990. 14p. Sponsored by U.S. Department of Defense; U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. CONTRACT W31RPD-7-D4041. (CONF-900140–7: SPIE optics, electro-optics and laser applications in science and engineering conference and exhibition, Los Angeles, CA (USA), 20-25 Jan 1990). Order Number DE90007241. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We have numerically investigated the effect of random fluctuations on uncompensated (open-loop) and phase-compensated (closed-loop) small-scale thermal blooming instabilities of a collimated beam propagating through refractive index turbulence. We used the ORACLE time-dependent, three space-dimensional, wave-optics code on a Cray X-MP. The Monte Carlo random wind fields, v(z), were exponentially correlated along the propagation direction, z. The small scale instabilities are present up to a threshold value of the rms random wind, beyond which beam propagation appears to be stable; the threshold value is nearly independent of the correlation length as long as the latter is much shorter than both the length of the thermal blooming region and the Rayleigh range of dominant perturbations. The open-loop calculations use a plane wave "beam" and a uniform medium. The Strehl ratio at 50 waves of thermal blooming OPD remains approximately constant while $S \geq 2.3$ and then it decreases rapidly as S decreases. The closed-loop calculations use a large Fresnel number finite beam, a non-uniform medium of length 2L, absorption α exp(-z/L), and a Hufnagel-Valley type C_N^2 profile whose r_0 Fresnel number was 24. For $10 \leq N_p \leq 40$ we see no evidence of the closed-loop instability at a wind clearing time (20 waves) for $S \geq (54 \pm 2)/N_p$, where $N_p = \pi\Lambda_p^2/4\lambda L$ and Λ_p is twice the actuator spacing simulated by a Fourier filter. This result suggests that the ratio of the turbulence scintillation rate to the closed-loop gain for a uniform wind determines the threshold. 12 refs., 8 figs.

20253 (UCRL–102674) **Turbulent mixing effects in models of thermal blooming.** Chambers, D.H.; Viecelli, J.A.; Karr, T.J. Lawrence Livermore National Lab., CA (USA). 16 Jan 1990. 9p. Sponsored by U.S. Department of Defense; U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Contract W31RPD-7-D4041. (CONF-900140–6: SPIE optics, electro-optics and laser applications in science and engineering conference and exhibition, Los Angeles, CA (USA), 20-25 Jan 1990). Order Number DE90007245. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A two-dimensional hydrodynamic model incorporating turbulent mixing is derived by averaging the three-dimensional hydrodynamics equations over slabs of thickness L in the direction of propagation. The resulting equations are identical with those for two-dimensional, incompressible flow with additional terms representing the average effect of velocity fluctuations within each slab. These equations depend only parametrically on the coordinate in the direction of propagation. The extra terms have a simple physical interpretation but must be modeled in order to close the equations. Correlation times of scintillations are computed from a numerical simulation of plane-wave blooming using this model. A comparison with the correlation times from simulations with only wind shear indicate that the effect of turbulent mixing is relatively small for typical values of the Kolmogorov inner scale. 4 refs., 3 figs.

4506 Chemical and Biological

20254 (AD-A–214200/8/XAB) **Aerosol extinction transmissometry at visible and infrared wavelengths applied to specialized problems in CB defense. Technical report, January 1978-December 1982.** Carlon, H.R. Chemical Research, Development and Engineering Center, Aberdeen Proving Ground, MD (USA). Oct 1989. 40p. (CRDEC-TR–110). Available from NTIS, PC A03/MF A01.

The report compiles, updates, and discusses several novel techniques in aerosol extinction transmissometry, in the visible and infrared wavelength regions, that are applicable to the solution of a variety of specialized problems in CB defense. These techniques share common elements with one another, and so they are brought together here for easy reference. Complex calculations of optical scattering using high-speed electronic computers have become so commonplace that the technology has evolved into several specialty fields, e.g., extinction spectroscopy, angular-scattering measurements and nephelometry. As a consequence, the overall technology and our ability to remotely characterize or quantitatively analyze atmospheric aerosols might be further advanced than is realized by workers in the individual disciplines who do not have the time to keep up with advances in other disciplines. This report examines techniques of transmission (extinction) and turbidity spectroscopy, polarization and angular scattering measurements, and related developments and concludes that computer programs can be written to optimize desired parameters in interdisciplinary investigations. An appendix discusses sampling, which is a complicated problem in aerosol physics. A technique described to monitor continuously the mass concentration of monodisperse test aerosols using a He:Ne laser.

20255 (AD-A–214269/3/XAB) **Commander's CBR-D Decision Training Aid (DECAID) demonstration model and design refinement. Final report, February 1988-July 1989.** Eldredge, D.; Hartigan, J.; Treaster, D.; Stabb, J.; Tijerina, L. Battelle Columbus Labs., OH (USA). 12 Jul 1989. 148p. Available from NTIS, PC A07/MF A01.

Chemical, Biological, and Radiological Defense (CBR-D) training has been identified by the fleet as deficient insofar as it has been dealt with as an independent topic, not closely interrelated with the overall shipboard mission that may be taking place in the CBR environment. The CBR-D area is unique in that the defensive measures (i.e., closing up the ship and outfitting the crew in protective clothing) cause nearly as much mission degradation as would an attack itself. Shipboard Damage Control Assistants need sophisticated training to be able to effectively weigh the risks associated with employing CBR defense measures, and to make appropriate choices consistent with ship mission. Effective risk-management training is made especially difficult due to the fact that no experienced mentors are avialable who have experienced Naval operations in a CBR-D environment. The Damage Control Assistant course of instruction currently teaches established CBR-D doctrine and procedures in a classroom setting, but does not provide operational experience in the area of CBR-D risk management, or integrate CBR-D decisions into the overall tactical picture.

54 ENVIRONMENTAL SCIENCES

Refer also to citation(s) 19354, 19704, 19808

20256 (EPS–89-04698) **Proceedings of the sixth technical seminar on chemical spills.** Environment Canada, Ottawa, ON (Canada). Environmental Protection Service. 1989. 171p. (CONF-8906284–: 6. technical seminar on chemical spills, Calgary (Canada), 5-6 Jun 1989; MICROLOG–89-04698). Available from PC Environment Canada, Departmental Library, Ottawa, PQ, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

A seminar on chemical spills featured presentations of papers on topics including physical properties of spills, the fate of spills in the environment, spill response procedures, chemicals monitoring, chemical analysis, spill containment, and removal of contaminants. Separate abstracts have been prepared for 3 papers from this seminar.

20257 (ORNL/M–1002) **Biomedical and Environmental Sciences Program at Oak Ridge National Laboratory.** Oak Ridge National Lab., TN (USA). Jan 1990. 131p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90007107. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

This overview provides programmatic and other information about the Oak Ridge National Laboratory (ORNL) Biomedical and Environmental Sciences (BES) Program. Our mission is to conduct for our sponsors quality research and development (R&D) using our local resources and collaborative groups in Oak Ridge and elsewhere. Our goals are excellence in both basic and applied research, appropriate educational training activities, and technology transfer. A primary mission of the BES Program is to identify and to understand important environmental and health effects associated with the energy technologies including (1) basic and applied biological research on genetic and somatic effects of radiation and chemical exposures; (2) relationships of primary energy-related effluents to global environmental issues; (3) development of human health and environmental assessments and risk analyses in these areas; and (4) development of advanced instrumentation, measurement techniques, and methodologies for applying nuclear technologies to medical diagnosis and treatment. A secondary mission is to contribute to relevant educational activities and the revitalization of American industry through a variety of associations and activities including cooperation with industrial consortia.

5401 Environmental Sciences, Atmospheric

Refer also to citation(s) 19207, 19242, 19247, 19248, 19272, 19273, 19350, 19356, 19418, 19419, 19427, 19428, 19429, 19430, 19431, 19432, 19433, 19434, 19435, 19636, 19637, 19641, 19642, 19645, 19654, 19665, 19694, 19708, 19724, 19725, 19733, 19752, 19768, 19771, 19772, 19773, 19779, 19814, 19981, 20252, 20253, 20366, 20367, 20368, 20393, 20456, 20466, 20470, 20475, 20483, 20487

20258 (AD-A–214422/8/XAB) **NO_2 photodissociation dynamics. Final report, 1 November 1986-30 September 1989.** Slanger, T.G. SRI International, Menlo Park, CA (USA). Sep 1989. 89p. Available from NTIS, PC A05/MF A01.

The studies carried out under the present contract have all involved investigations of the photophysics and photochemistry of two nitrogen oxide molecules, NO and NO_2. As well as being intrinsically interesting, these molecules are important from the point of view of atmospheric chemistry, and the NO_2 molecule is a leading candidate as the emitting molecule that has been observed in the space shuttle glow. Major findings of these studies include the following observations: (1) Multiphoton dissociation of NO_2 by green light produces highly excited products, specifically, highly vibrationally excited O_2 and NO, and O(S). (2) Two-photon absorption of 268-280 nm radiation by NO results in production of the first excited state of the N-atom, N(2D), an atmospherically important species that is difficult to produce by any other photodissociative techniques.

20259 (Beitraege–1/89, pp. 1-53) **Valuating report on measurements of radionuclide concentrations in aerosols 1987.** Henrich, E. (Bundesanstalt fuer Lebensmitteluntersuchung und Lebensmittelforschung, Vienna (Austria). Abt. Strahlenschutz); Friedrich, M.; Zapletal, M.; Haider, W. Bundesministerium fuer Gesundheit und Umweltschutz, Vienna (Austria). 1989. (In German). In *Radioactivity monitoring network: Measurements 1987.* Order Number DE90617487. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

Methods of sample collection, sample preparation and data processings are outlined. A lot of data are presented in tables, figures and maps. The evaluation consists of hypotheses about the origin of the particular nuclides. 8 tabs., 15 figs., 10 refs. (qui).

20260 (BF-R–65.3999-7) **Application of remote sensing technique for the measuring of road traffic emissions.** Diehl, W.; Wiesemann, W. Battelle-Institut e.V., Frankfurt am Main (Germany, F.R.); Umweltbundesamt, Berlin (Germany, F.R.). Jun 1986. 84p. (In German). Contract UFOPLAN-Nr. 10402123. Available from Battelle-Institut e.V., Frankfurt am Main (Germany, F.R.). Available from Battelle-Institut e.V., Frankfurt am Main (Germany, F.R.).

A transportable laser system for remote sensing of road-traffic emissions (carbon monoxide) has been developed and field tested

at different sites in the city of Frankfurt. Based on the DAS-technique the system yields mean values of the species density (CO) across the long-range (several hundred meters) mesurement-path. Interference with other absorbing species as well as varying operating conditions (power of the lead-salt-laser etc.) are compensated by using the 2f-derivative technique. There is fair agreement between laser remote sensing data and in-situ measurements performed by University of Frankfurt, City of Frankfurt and Pilotstation Frankfurt. The time for starting operation after transportation of the system was two hours, time of availableness during the campaigns was better than 90%. It appeared sufficient to have technical checks and readjustments only once per day. The feasibility for multicomponent measurements (CO and NO_x) is discussed. (orig.) With 71 refs., 3 tabs., 35 figs.

20261 **Coping with climate change: Proceedings.** Topping, J.C. Jr. (ed.). 725p. Climate Institute, Washington, DC (US) (Jun 1989). Sponsored by U.S. DOE Environment Health & Safety. DOE Contract FG01-89EH89009. From 2. North American conference on preparing for climate change; Washington, DC (USA); 6-8 Dec 1988.

The Second North American Conference on Preparing for Climate Change may be the most ambitious assemblage of experts ever to assess impact and response strategies to the twin challenges of greenhouse warming and stratospheric ozone depletion. Presentations were made by over 160 scientists, environmental leaders and policy makers from the Western Hemisphere, Europe and Asia in 38 sessions over a three day period. Chapters in this volume correspond to the seven regional panels of the Second North American Conference, with discussions of implications of climate changes for the Caribbean, the Arctic, California, the Southern United States, the Chesapeake Bay, Atlantic Canada and New England, and the Great Lakes. This book also contains a policy overview of the climate challenge with contributions from US, Canadian, British and Caribbean governmental and corporate leaders. A chapter devoted to a scientific overview of climate change includes a skillful overview of the key scientific and policy issues involved in greenhouse warming, a seminal article on regional implications of climate change and the potential impacts of global warming on droughts and floods, and a panel discussion involving four of the world's leading stratospheric scientists. Individual papers were processed separately for the data base.

20262 (CONF-900483–1) **Predicting effects of global climate change on reservoir water quality and fish habitat.** Chang, L.H. (Duke Univ., Durham, NC (USA). School of Forestry and Environmental Studies); Railsback, S.F. Oak Ridge National Lab., TN (USA). [1989]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 1990 American Society of Civil Engineers Water Resources Planning and Management Division specialty conference; Fort Worth, TX (USA); 17-20 Apr 1990. Order Number DE90003674. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper demonstrates the use of general circulation models (GCMs) for assessing global climate change effects on reservoir water quality and illustrates that general conclusions about the effects of increased carbon dioxide (CO_2) concentrations on water resources can be made by using GCMs. These conclusions are based on GCM predictions of the climatic effects of doubling CO_2 concentrations (the 2 x CO_2 scenario). We also point out inadequacies in using information from GCM output alone to simulate reservoir water quality effects of climate change. Our investigation used Douglas Lake, a large multipurpose reservoir in eastern Tennessee, as an example. We studied water temperature and dissolved oxygen (DO), important water quality parameters that are expected to respond to a changed climate. Finally, we used the temperature and DO requirements of striped bass as an indicator of biological effects of combined changes in temperature and DO. 3 refs., 1 fig.

20263 (DOE/NV/10594–T1) **A guide to archival collections relating to radioactive fallout from nuclear weapon testing: Eighth edition.** History Associates, Inc., Rockville, MD (USA). Oct 1989. 92p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC08-87NV10594. Order Number DE90006340. Available from NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

This guide has been prepared by professional historians who have a working knowledge of many of the record collections, included in the following pages. In describing materials, they have tried to include enough information so that persons unfamiliar with the complexities of large record systems will be able to determine the nature of the information in, and the quality of, each record collection. The guide is organized alphabetically by the means of the record repositories, not by the organizations which have custody of the records. It should be noted that arrangement by location does not reveal at a single glance all of the materials that may have originated in a specific laboratory, research center, or government agency. For example, records originated in one of the Atomic Energy Commission's national laboratories may, in some cases, be listed under the Federal Records Centers to which they have been retired. Thus, this guide includes an index of agencies originating documents and pages listing those agencies.

20264 (EPS–89-04698, pp. 19-43) **Heavy gas dispersion in terrain with obstacles.** Murphy, M.C. (Rowan, Williams, Davies, and Irwin Inc., Guelph, ON (Canada)); Heidorn, K.C.; Irwin, P.A.; Davies, A.E. Environment Canada, Ottawa, ON (Canada). Environmental Protection Service. 1989. (CONF-8906284–: 6. technical seminar on chemical spills, Calgary (Canada), 5-6 Jun 1989; MICROLOG–89-04698). In *Proceedings of the sixth technical seminar on chemical spills.* Available from PC Environment Canada, Departmental Library, Ottawa, PQ, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Scale model testing was conducted in a boundary layer wind tunnel to determine the impact of arrays of obstacles on the path of a heavy gas cloud. The parameters of interest included terrain roughness, flow path, arrival time, dilution rate, and concentration fluctuations. Cloud arrival times were first determined from flow visualizations of the cloud translation, and later supplemented with concentration fluctuations measured with a high frequency flame ionization detector. The obstacle arrays consisted of cube blocks arranged on a rectangular grid with uniform spacing. Flow visualization of the cloud passage during calm conditions showed that immediately after a release with uniformly-spaced obstacles, a circular cloud formation was observed, while at later times the cloud tended toward a surprisingly exact diamond shape. As the wind speed was increased, the diamond shape became less distinguishable. The observed concentration profiles showed an increased dose-time relation with obstacles present. The concept of a threshold wind speed was identified, above which cloud behaviour was not greatly affected by the presence of the obstacles. 6 refs., 17 figs., 1 tab.

20265 (EPS–89-04698, pp. 45-53) **Rapid on-site monitoring of ambient PCB [polychlorinated biphenyl] levels during clean-up and destruction activities.** Brou, G.B. De (Ontario Ministry of the Environment, Toronto, ON (Canada)); Ng, A.C.W. Environment Canada, Ottawa, ON (Canada). Environmental Protection Service. 1989. (CONF-8906284–: 6. technical seminar on chemical spills, Calgary (Canada), 5-6 Jun 1989; MICROLOG–89-04698). In *Proceedings of the sixth technical seminar on chemical spills.* Available from PC Environment Canada, Departmental Library, Ottawa, PQ, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

A polychlorinated biphenyl (PCB) analysis technique has been developed which utilizes the real-time monitoring capabilities of the Ontario environment ministry's mobile trace atmospheric gas analyzer (TAGA) systems. An automated short term adsorber (ASTA) interfaced with the TAGA's direct air inlet serves to trap and concentrate PCBs prior to mass spectrometric analysis. With the introduction of the ASTA, the TAGA's analytical detection limits for PCBs were reduced to levels below the Ministry's regulatory guideline for ambient PCBs (0.45 $\mu g/m^3$ for a 30-minute sample). Since 1985, the ASTA/TAGA technique has been used in nine mobile air monitoring surveys where the potential for PCB release existed; mobile PCB destruction processes, removal of PCB contaminated sediments, and PCB spillage following the destruction of a storage facility by fire. 5 figs., 2 tabs.

20266 (ES/ESH–8/V1) **Oak Ridge Reservation environmental report for 1988: Volume 1, Narrative, summary, and conclusions.** Prince, N.L. (ed.). Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA). May 1989. 304p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC05-84OR21400. Order Number DE90006438. Available from NTIS, PC A14/MF A01; OSTI; INIS; GPO Dep.

This two-volume report, the Oak Ridge Reservation Environmental Report for 1988, is the eighteenth in an annual series that began in 1971. It reports the results of a comprehensive, yearround program to monitor the impact of operations at the three major US Department of Energy (DOE) production and research installations in Oak Ridge on the immediate areas' and surrounding region's groundwater and surface waters; soil; air quality; vegetation and wildlife; and, through these multiple and varied pathways, the resident human population. Information is presented for the environmental monitoring Quality Assurance (QA) Program, audits and reviews, waste management activities, and special environmental studies.

20267 (ES/ESH–8/V2) **Oak Ridge Reservation environmental report for 1988: Volume 2, Data presentation.** Prince, N.L. (ed.). Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA). May 1989. 250p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC05-84OR21400. Order Number DE90006430. Available from NTIS, PC A11/MF A01; OSTI; INIS; GPO Dep.

The first two volumes of this report are devoted to a presentation of environmental data and supporting narratives for the US Department of Energy's (DOE's) Oak Ridge Reservation (ORR) and surrounding environs during 1988. Volume 1 includes all narrative descriptions, summaries, and conclusions and is intended to be a "stand-alone" report for the ORR for the reader who does not want to review in detail all of the 1988 data. Volume 2 includes the detailed data summarized in a format to ensure that all environmental data are represented in the tables. Narratives are not included in Volume 2. The tables in Volume 2 are addressed in Volume 1. For this reason, Vol. 2 cannot be considered a stand-alone report but is intended to be used in conjunction with Volume 1.

20268 (GEPP-EV–1193) **Pinellas Plant site environmental report for calendar year 1988.** Klein, R.D. General Electric Co., Largo, FL (USA). Neutron Devices Dept. 1 Jun 1989. 46p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00656. Order Number DE90006447. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The environmental monitoring programs maintained by the Pinellas Plant are designed to: (1) determine the efficiencies of treatment and control mechanisms for environmental releases, (2) provide measurements of discharge concentrations for comparison with applicable standards, (3) assess the concentrations of these discharges in the on-site and off-site environment, and (4) provide a data base for computer programs to calculate the potential dose to the public resulting from the operation of the Pinellas Plant. The environmental effects of radiological and nonradiological effluents from the operation of the Pinellas Plant have been demonstrated to be insignificant. 24 refs., 7 figs., 12 tabs.

20269 (N–90-12059) **NASA/MSFC FY88 global scale atmospheric processes research program review.** Wilson, G.S.; Leslie, F.W.; Arnold, J.E. National Aeronautics and Space Administration, Huntsville, AL (USA). George C. Marshall Space Flight Center. Feb 1989. 92p. (NASA-TM–100357;NAS–1.15:100357). Available from NTIS, PC A05/MF A01.

Interest in environmental issues and the magnitude of the environmental changes continues. One way to gain more understanding of the atmosphere is to make measurements on a global scale from space. The Earth Observation System is a series of new sensors to measure globally atmospheric parameters. Analysis of satellite data by developing algorithms to interpret the radiance information improves the understanding and also defines requirements for these sensors. One measure of knowledge of the atmosphere lies in the ability to predict its behavior. Use of numerical and experimental models provides a better understanding of these processes. These efforts are described in the context of satellite data analysis and fundamental studies of atmospheric dynamics which examine selected processes important to the global circulation.

20270 (N–90-12101) **Ozone depletion, greenhouse gases, and climate change.** Mooney, H.A.; Baker, D.J. Jr.; Bretherton, F.P.; Burke, K.C.; Clark, W.C.; Davis, M.B.; Dickinson, R.E.; Imbrie, J.; Malone, T.F.; Mcelroy, M.B. National Research Council, Washington, DC (USA). 1989. 135p. (NASA-CR–185323;NAS–1.26:185323;LC–88-31544). Available from NTIS, PC A07/MF A01.

This symposium was organized to study the unusual convergence of a number of observations, both short and long term that defy an integrated explanation. Of particular importance are surface temperature observations and observations of upper atmospheric temperatures, which have declined significantly in parts of the stratosphere. There has also been a dramatic decline in ozone concentration over Antarctica that was not predicted. Significant changes in precipitation that seem to be latitude dependent have occurred. There has been a threefold increase in methane in the last 100 years; this is a problem because a source does not appear to exist for methane of the right isotopic composition to explain the increase. These and other meteorological global climate changes are examined in detail.

20271 (N–90-13228) **Mesoscale acid deposition modeling studies. Final report, July 1986-July 1989.** Kaplan, M.L.; Proctor, F.H.; Zack, J.W.; Karyampudi, V.M.; Price, P.E.; Bousquet, M.D.; Coats, G.D. Mesoscale Environmental Simulations and Operations, Inc., Hampton, VA (USA). Dec 1989. 114p. (NASA-CR–4262;NAS–1.26:4262). Available from NTIS, PC A06/MF A01.

The work performed in support of the EPA/DOE MADS (Mesoscale Acid Deposition) Project included the development of meteorological data bases for the initialization of chemistry models, the testing and implementation of new planetary boundary layer parameterization schemes in the MASS model, the simulation of transport and precipitation for MADS case studies employing the MASS model, and the use of the TASS model in the simulation of cloud statistics and the complex transport of conservative tracers within simulated cumuloform clouds. The work performed in support of the NASA/FAA Wind Shear Program included the use of the TASS model in the simulation of the dynamical processes within convective cloud systems, the analyses of the sensitivity of microburst intensity and general characteristics as a function of the atmospheric environment within which they are formed, comparisons of TASS model microburst simulation results to observed data sets, and the generation of simulated wind shear data bases for use by the aviation meteorological community in the evaluation of flight hazards caused by microbursts.

20272 (NEDOJ-P–8820) **Research on sources for energetic technological development.** New Energy Development Organization, Tokyo (Japan). Mar 1989. 120p. (In Japanese). Order Number DE90753153. Available from NTIS (US Sales Only), PC A06/MF A01.

Technical sources were investigated and picked out about the energy conservation technology contributing toward alleviating groval warming, which in particular becomes to the focus of public attention in the groval atmospheric reserve problems, and the results were classified and studied from the sides of the technology on effective utilization and contribution to soroundings. As the result, the trend of development on energy conservation technology was proposed. Technical resources expected to contribute toward groval environmental issue, are high efficiency and energy saving combustion technology, LNG utilization technology, energy saving reaction process, multipurpose utilization of absorption cycle, engine based automotive technology, material technology, waste heat recovery and utilization system, dispersed independent energy system, etc. The problems to be technically developed, are thermal complex, combined industrial-commercial cascade use for thermal energy, energy-saving urban energy system, total energy process, international energy cooperation system, etc. 5 refs., 22 figs., 15 tabs.

20273 (PB–90-125675/XAB) **Reassessment of the economic effects of ozone on US agriculture.** Adams, R.M.; Glyer, J.D.; Johnson, S.L.; McCarl, B.A. Oregon State Univ., Corvallis, OR (USA). Dept. of Agricultural and Resource Economics. c 1989. 11p.

(TECHNICAL PAPER–8812). Available from NTIS, PC A03/MF A01.

Pub. in Jnl. of the Air Pollution Control Association, Vol. 39, 960-968(1989).

The ability of economists to assess the agricultural effects of one important pollutant, tropospheric ozone, has been improved by the recently completed National Crop Loss Assessment Network (NCLAN). The structure, protocols, and initial plant science findings of the U.S. Environmental Protection Agency program have been presented in previous journal articles. In related articles the authors reported the economic consequences of those preliminary ozone crop-yield effects and summary plant science findings have now been published. The authors provide here a more complete analysis of estimated benefits from reductions in troposphere ozone based on the final results of the NCLAN plant science research. While uncertainties still remain, these improvements would result in more defensible estimates of the magnitude of ozone's effects on U.S. agriculture.

20274 (PB–90-125717/XAB) **Nitrogen saturation in northern forest ecosystems: Excess nitrogen from fossil-fuel combustion may stress the biosphere.** Aber, J.D.; Nadelhoffer, K.J.; Steudler, P.; Melillo, J.M. New Hampshire Univ., Durham, NH (USA). c 1989. 11p. Available from NTIS, PC A03/MF A01.

Pub. in Bioscience, Vol. 39, No. 6, 378-386(1989).

In the article the authors provide a formal definition of nitrogen saturation and set forth a series of testable hypotheses regarding the states of forest-ecosystem response to chronic nitrogen deposition. These hypotheses are used to suggest early indicators of nitrogen saturation and to discuss the potential implications of nitrogen saturation of forest ecosystems over large geographic areas. Possible effects include elevated concentrations of nitrate, aluminum, and hydrogen in streams, which would decrease water quality; frost damage or other disruptions of physiological function that would reduce productivity in conifer stands; increase cation leaching from soils and nitrate losses that would lead to reduced soil fertility and increased acidity; and possible increases in emissions of trace gases such as nitrous oxide, which may alter atmospheric chemistry and contribute to the warming of Earth's atmosphere (the greenhouse effect).

20275 (PB–90-125865/XAB) **Growth parameter and yield component response of field corn to simulated acid rain.** Banwart, W.L.; Porter, P.M.; Ziegler, E.L.; Hassett, J.J. Illinois Univ., Urbana, IL (USA). Dept. of Agronomy. c 1988. 11p. Available from NTIS, PC A03/MF A01.

Pub. in Environmental and Experimental Botany, Vol. 28, No. 1, 43-51(1988).

Acid rain occurs in the midwest. Studies to date have suggested minimal yield response of field corn to acid rain. However, small but significant reductions in yield have been shown for some cultivars under extreme conditions. To define further these yield changes the study examined the effect of simulated acid rain on parameters associated with corn yield. Cultivars B73 x Mo17 and Pioneer 3377 were shielded from ambient rain by two movable rain exclusion shelters. Six simulated rain treatments were applied biweekly within these shelters through the use of a nozzle distribution system. For the most part, growth and yield parameters were unaffected by simulated rain treatment. While the only significant yield reduction was a contrast of pH 3.0 and the average of all other treatments for B73 x Mo17, the reduction appears to be the result both of slightly fewer ears and slightly less successful ear fill.

20276 (PB–90-126004/XAB) **Characterization of emissions from the simulated open burning of scrap tires. Final report, August 1988-June 1989.** Ryan, J.V. Acurex Corp., Research Triangle Park, NC (USA). Environmental Systems Div. Oct 1989. 69p. Available from NTIS, PC A04/MF A01.

This report gives results of a small-scale combustion study, designed to collect, identify, and quantify products emitted during the simulated open burning of scrap tires. Fixed-combustion gas, volatile and semi-volatile organic, particulate, and airborne-metals data were collected under two burn conditions that varied by the size of tire material. Burn rates, varied by material size, were used to estimate potential emissions of identified products. Total estimated emissions of semi-volatile organics ranged from 10 to 50 g/kg of tire material burned. Monoaromatic and polyaromatic hydrocarbons were the predominant emission products identified. The presence of benzo(a)pyrene (BAP) in particulate extracts is of particular concern because it is a known carcinogen. The presence of zinc in gaseous particulate collection was also verified and quantified. Several trends were evaluated relating emission products to burn rates.

20277 (PB–90-126012/XAB) **NAPAP (National Acid Precipitation Assessment Program) emissions inventory: Overview of allocation factors, 1985. Final report, November 1988-June 1989.** Walters, R.A.; Modica, L.G.; Fratt, D.B. Alliance Technologies Corp., Bedford, MA (USA). Oct 1989. 111p. Available from NTIS, PC A06/MF A01.

This report documents the development of temporal, spatial, and species allocation factors for the 1985 National Acid Precipitation Assessment Program (NAPAP) anthropogenic point- and area-source emissions inventories. These allocation factors are used to apportion annual emissions totals into gridded, hourly, speciated emissions estimates suitable for use as input to atmospheric transport models such as the Regional Acid Deposition Model. The temporal, spatial, and species allocation factors are discussed in detail in separate report sections. Each section contains a description of the methodology for application of the factors, a discussion of data sources, and documentation of the activities undertaken to create the allocation factor data sets used in the 1985 NAPAP resolved modeling inventories.

20278 (PB–90-126038/XAB) **EPA/IFP (Environmental Protection Agency/Institute Francais Du Petrole) European workshop on the emission of nitrous oxide from fossil-fuel combustion: Rueil-Malmaison, France, June 1-2, 1988.** Ryan, J.V.; Srivastava, R.K. Acurex Corp., Research Triangle Park, NC (USA). Environmental Systems Div. Oct 1989. 134p. Available from NTIS, PC A07/MF A01.

This report summarizes the proceedings of an EPA/Institut Francais du Petrole (IFP) cosponsored workshop addressing direct nitrous oxide (N2O) emission from fossil-fuel combustion. The third in a series, it was held at the IFP in Rueil-Malmaison, France, on June 1-2, 1988. Increasing atmospheric N2O concentrations have been linked to depletion of stratospheric ozone (O3) and to global-climate warming. The combustion of fossil fuels has been identified as a potential major anthropogenic source of N2O. The workshop had two goals: (1) to exchange information among various international research and industrial groups that are involved in N2O chemistry, modeling, and measurement; and (2) to develop a network for coordinating future related efforts.

20279 (PB–90-128984/XAB) **Health-hazard evaluation report HETA 88-069, 88-070-1964, US Department of Transportation, Maritime Administration, Benicia, California and Fort Eustis, Virginia.** Reh, C.M.; Fleeger, A.K.; Collins, J.W. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). 1989. 15p. (HETA–88-069). Available from NTIS, PC A03/MF A01.

A study was made of possible reasons for workers losing time from work at the Maritime Administration Reserve Fleets at Benicia, California and Fort Eustis, Virginia. At these worksites, activities associated with the mooring, preservation and maintenance of ships in the National Defense Reserve was undertaken. Most of the work involved manual materials handling tasks associated with the movement of ships in and out of the fleet such as the handling of anchors, anchor inspecting and maintaining the engine room, cargo holds, and deck machinery with time spent in welding, metal working, painting, and other maintenance activities. The most frequent injuries occurring to workers at these sites included back-muscle strains and sprains, groin pulls and hernias. Less prevalent injuries included eye injuries due to foreign objects, nail punctures to the soles of the feet and muscle strains and sprains. There was also potential exposure to asbestos observed at both sites. A potential health hazard existed from pulling steel cable and nylon rope, lifting and carrying marine batteries, nail punctures, slips and falls, vibrating handtools, and foreign bodies in the eyes. Measures for lowering the risks of musculoskeletal and traumatic injuries and for reducing possible asbestos exposures are recommended.

20280 (PB–90-129024/XAB) **Health-hazard evaluation report HETA 87-159-1962, Harley Davidson Motor Company, Tomohawk, Wisconsin.** Stephenson, R.L.; Sinks, T.L.; Tubbs, R.L.; Hughes, R.T.; Weiai, W. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). 1989. 37p. (HETA–87-159-1962). Available from NTIS, PC A03/MF A01.

A study was made of possible exposures to styrene and fibrous glass, and reported respiratory symptoms at the Harley Davidson Motor Company Division, Tomohawk, Wisconsin. The company employed 82 production workers, and two maintenance workers at this shop. Various fibrous-glass and plastic-reinforced motorcycle components were manufactured at the site. All measurements of acetone and styrene taken indicated that exposures were far below those suggested as exposure limits. Respiratory symptoms, which may have been linked to occupational exposures, were noted in two sanders. Measurements of noise exposure indicated that two thirds of the full-shift noise exposures were in excess of the NIOSH recommended levels of 85 decibels-A. The report concludes that overexposures to acetone or styrene did not occur at the time of the survey. Specific measures for ameliorating potential health hazards and for bringing the noise levels into acceptable ranges are recommended.

20281 (PB–90-129040/XAB) **Health-hazard evaluation report HETA 88-077-1969, Consolidated Freightways, Peru, Illinois.** Blade, L.M.; Savery, H. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). 1989. 33p. (HETA–88-077-1969). Available from NTIS, PC A03/MF A01.

A study was made of possible hazardous working conditions at Consolidated Freightways, Peru, Illinois. The dock workers were complaining of respiratory tract and eye irritation, the production of black colored mucus or phlegm, other respiratory difficulties, and headaches. The night shift was experiencing the most difficulties; this was the time when operations were heaviest. The function of the terminal was to receive large, long-distance loads, and break them down into smaller, short-distance loads. The workers used forklift trucks to move cargo. Workers were exposed to diesel-engine exhaust emissions, particularly during cold weather as the engines were left running to avoid difficult start-up problems. Airborne exposures were below recommended limits for all materials tested with the possible exception of the benzene extractable fraction of diesel particulate. A self-administered questionnaire was completed by 115 workers concerning their medical status. The report concludes that the irritative effects described were consistent with exposure to diesel exhaust. Efforts should be made to reduce or eliminate emissions from diesel forklifts trucks, improve ventilation, and provide washing and clothes changing facilities.

20282 (PB–90-129057/XAB) **Health-hazard evaluation report HETA 84-426-1963, Ormet Corporation, Hannibal, Ohio.** Hartle, R.; Singal, M. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). 1989. 32p. (HETA–84-426-1963). Available from NTIS, PC A03/MF A01.

An evaluation was made of possible long-term exposure to potroom gases, fumes, and dusts at Ormet Corporation, Hannibal, Ohio. The facility was a producer of primary aluminum, had six potrooms, each composed of two buildings housing 86 pots, for a total of 1032 pots. Excessive exposures to fluorides were determined among crane operators, particularly among cranemen involved with the placement of new carbon anodes in the pots. Personal samples for fluoride obtained from these men ranged from 0.95 to 3.61 mg/m^3. Sixteen percent of workers completing a medical questionnaire reported symptoms suggestive of asthma; in 13 of these cases the asthma was temporally related to work and symptoms worsened in or near the potroom. Neurologic effects were no more prevalent among current potroom workers than among other participants in the medical review. However, each was more prevalent among workers who had ever worked in the potroom. The report concludes that there was a potential for excess exposures to fluorides among potroom crane operators. There was no convincing evidence of an association between exposure to aluminum and neurologic effects. Specific engineering controls and work practices are outlined.

20283 (PB–90-129073/XAB) **Health-hazard evaluation report HETA 87-411-1972, Naval Weapons Support Center, Crane, Indiana.** Klincewicz, S.L.; Reh, C.M. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). 1989. 29p. (HETA–87-411-1972). Available from NTIS, PC A03/MF A01.

The Medical Department of the Naval Weapons Support Center, in Crane, Indiana requested an evaluation of possible hazardous working conditions at the site. The primary area of concern was Building 121 which contained an office and shop area located above a cafeteria. Soldering operations were performed without local exhaust ventilation in the shop area. Building 2516, a general office building, was also a concern. The possibility of formaldehyde exposure was also examined in Building 2958. Worker complaints included headache, nausea, sneezing, and eye irritation along with thermal discomfort. Trace amounts of various solvents and wipe samples which indicated contamination with several metals were reported. Elevated levels of carbon dioxide (CO_2) indicated that two of the buildings studied needed increased inputs of fresh makeup air through the ventilation systems. Temperature and relative humidity readings in three buildings were outside guideline specifications. The report concludes that, although unable to determine that a health hazard existed due to air contaminants, elevated CO2 levels indicate that more fresh air should be supplied by the ventilation systems. Specific measures to improve ventilation, thermal comfort, and work practices are recommended.

20284 (PB–90-129081/XAB) **Health-hazard evaluation report HETA 88-082-1971, Jostens Inc., Princeton, Illinois.** Seitz, T.; Driscoll, R. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). 1989. 27p. (HETA–88-082-1971). Available from NTIS, PC A03/MF A01.

Jostens Incorporated, Princeton, Illinois, was the subject of a study of possible hazardous working conditions. Jostens was a jewelry manufacturer producing rings, medallions, tie tacks, belt buckles, and service awards. There were about 15 employees in the plating department where jewelry was cleaned by either suspending the piece in a trichloroethylene (TCE) vapor degreaser or by immersing it in acid or alkali baths. Six plating lines were located in the department, each with its own exhaust ventilation. Personal breathing-zone air concentrations of TCE ranged from 14.7 to 33.4 parts per million (ppm). Area air samples ranged from 49.2 to 64.1ppm at the TCE degreaser and ultrasonic cleaner, respectively, indicating these were major contributors to the pollution. Of the 25 employees responding to a symptom questionnaire, seven reported multiple symptoms consistent with solvent exposure. Cases of colon cancer, ovarian cancer, kidney and breast cancer were identified among polish department employees. Only one employee with cancer had worked at Jostens more than 10 years before diagnosis. The report concludes that a hazard existed to TCE exposure. Improvements in engineering controls, safe work practices, and the use of personal protective equipment are recommended.

20285 (PB–90-129099/XAB) **Health-hazard evaluation report HETA 87-370-1973, Native Textiles, Glenn Falls, New York.** Reh, C.M. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). 1989. 22p. (HETA–87-370-1973). Available from NTIS, PC A03/MF A01.

A study was made of possible hazardous working conditions at Native Textiles, Glens Falls, New York. The company manufactured lace, tricot, and specialty fabrics and employed about 400 prople. Possible exposure to a melamine/formaldehyde resin existed when the lace was passed through this mixture to provide durability and body. Following accelerated polymerization, the lace was divided into individual strands by a thread-drawing machine. During the processing by this machine a fine dust containing the polymerized resin was generated. The dust covered the arms and clothing of the workers. Ten of 17 air samples tested for formaldehyde were above 0.1 part per million (ppm) levels and the total and respirable dust levels were between 0.1 and 0.2mg/m3. In the finishing area low levels of 1,1,1-trichloroethane and traces of toluene, xylene, and various alkyl substituted benzenes were measured. Workers suffered irritation of the upper respiratory tract, skin and eyes. A hazard existed from exposure to dust from thread drawing and spooling of resin coated lace; formaldehyde levels above 0.1ppm may have increase the irritative effects of dust exposures. Improvement in the ventilation system, use of a resin system which contains less formaldehyde, issuance of protective clothing and

equipment, and the option of reassignment for particularly sensitive employees are recommended.

20286 (PB–90-129107/XAB) **Health-hazard evaluation report HETA 87-092-1967, Iowa Industrial Hydraulics, Pocahontas, Iowa.** Gupta, S.; Laubli, T.; Sinks, T. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). 1989. 17p. (HETA–87-092-1967). Available from NTIS, PC A03/MF A01.

A study was made of possible hazardous working conditions at Iowa Industrial Hydraulics, Pocahontas, Iowa. About 140 production workers were employed in manufacturing hydraulic pumps. The major exposures investigated were to nine different types of cutting fluids with their biocides, the solvent-based floor cleaner Marvella, mineral spirits, two hand cleaners, oils used for the lubrication of machines, and metal chippings. Most machines were supplied with coolant from a central system. There was no mechanism in place to clean the coolant and no regular monitoring was conducted for coolant concentration, pH, or bacterial or fungal counts. Workers had experienced an outbreak of dermatitis in September 1986 at which time the coolant in most machines had become dense, brown, and had a foul odor. Sampling revealed the coolant to be ten times more concentrated than it should have been and contaminated with lubricating oils. Medical histories, patch tests, and questionnaires were used to obtain data from the workers. The report concludes that workers exposed to Lubrisynplus with its biocide Ducide-20, or Trim-sol, or to Marvella had a significantly higher risk of developing dermatitis. Specific measures for fluid maintenance, employee education, hazard communication, and personal protection are recommended.

20287 (PB–90-129289/XAB) **Toxicology of complex mixtures of indoor air pollutants.** Lewtas, J. Environmental Protection Agency, Research Triangle Park, NC (USA). Health Effects Research Lab. c 1989. 27p. (EPA–600/D-89/243). Available from NTIS, PC A03/MF A01.

Pub. in Annual Review of Pharmacology and Toxicology 29, 415-139(1989).

This review focuses on strategies for assessing the toxicology of indoor air pollutant mixtures. These strategies are illustrated by reviewing the current problems and approaches to the toxicology of indoor air pollutants from three indoor source categories that make a major contribution to human exposure: environmental tobacco smoke, combustion emissions, and volatile organic compound (VOC) mixtures from materials and products. The strategies include assessment of: exposure and dosimetry, toxic effects of mixtures, causative agents in mixtures, and the predictability of toxicology from one mixture to another. Case studies from indoor air pollution are used to illustrate these strategies. Environmental tobacco smoke research on exposure and dosimetry illustrates new methods using biological markers. Unvented combustion sources such as kerosene heaters emit genotoxic incomplete combustion products and recent research is focused on identifying the genotoxic (causative) agents in these mixtures.

20288 (PB–90-129297/XAB) **Changes in pulmonary function and airway reactivity due to prolonged exposure to typical ambient ozone (O_3) levels.** Horstman, D.; McDonnell, W.; Folinsbee, L.; Abdul-Salaam, S.; Ives, P. Environmental Protection Agency, Research Triangle Park, NC (USA). Health Effects Research Lab. c 1989. 10p. (EPA–600/D-89/246). Available from NTIS, PC A02/MF A01.

Previously observed (JAPCA 38:28-35, 1988) pulmonary responses of delta FEV1 (-13%), moderate to severe pain upon inspiration, and a doubling of PD100 for methacholine following prolonged moderate exercise at 0.12 ppm O3 were of sufficient magnitude to warrant the assessing of responses at a lower range of concentrations, i.e., 0.08, 0.10 and 0.12 ppm O3. Exposures consisted of six 50-min exercises (VE approximately equals 40 L/min), each followed by 10-min rest; a 35-min lunch break was included. When compared with exposures to 0.00 ppm, substantial pulmonary function decrements, respiratory symptoms and increases in nonspecific airway reactivity were observed at all three O3 concentrations. For example, decreases in FEV1 ($P < 0.01$) of 7%, 7% and 12% were observed at 0.08, 0.10 and 0.12 ppm O3, respectively. The ratios ($P < 0.005$) of PD100 observed in 0.00 ppm to that in O3 were 1.56 at 0.08 ppm, 1.89 at 0.10 ppm, and 2.21 at 0.12 ppm O3. It is concluded that exercise representative of a day of moderate to heavy work or play performed during exposures to O3 at levels and pattern often found in ambient air induced clinically meaningful pulmonary responses.

20289 (PB–90-129362/XAB) **Pilot-scale ESP (electrostatic precipitator) and hydro-sonic scrubber parametric tests for particulate, metals, and HC1 emissions. Draft report.** Garg, S. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Jun 1989. 77p. (EPA–530/SW-90/009). Available from NTIS, PC A05/MF A01.

The EPA's Office of Solid Waste is currently developing additional regulations to control emissions of particulate matter, toxic metals, and hydrochloric acid (HC1) from hazardous-waste incinerators. Emissions data were collected to support these regulations; testing was conducted on two pilot-scale air-pollution-control systems installed and operated in Tulsa, OK. The test program took place between March 28 and April 4, 1989. This report represents the results of the testing program and describes the processes involved as well as the testing and analytical methods used. The primary objective of the test program was to collect particulate and toxic metals removal-efficiency and emissions data for two pilot-scale air-pollution-control systems: hydro-sonic wet scrubber; and beltran two-stage electrostatic precipitator.

20290 (PB–90-129370/XAB) **Comments of the National Institute for Occupational Safety and Health on The Occupational Safety and Health Administration's final rule on occupational exposure to asbestos, tremolite, anthophyllite, and actinolite. 29 CFR Parts 1910 and 1926, Docket No. H-033C.** National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). 1 Dec 1987. 6p. Available from NTIS, PC A02/MF A01.

The testimony contained a letter from J. D. Millar which discussed an epidemiologic study by NIOSH the purpose of which had been to examine the mortality of miners employed by the R. T. Vanderbilt Company, Gouverneur Talc Company Mine and Mill number 1. These miners were exposed to tremolite and anthophyllite. Based on internal and external reviews of the study at this point, it was decided not to proceed since there would be insufficient statistical power to render conclusive results. The study would also not have contributed new information concerning the environmental characteristics of the talc from the Gouverneur Talc District. Therefore the letter indicated that the position of NIOSH on the fibrosity of this talc would remain unchanged. The definition of asbestos used by NIOSH was restated. It is recommended that for regulatory purposes the definition be used in the current asbestos standard (29 CFR 1910.1001). The testimony also contained a copy of an earlier letter, from R. E. Glenn, which stated that further analysis of the mortality data of the cohort was to be suspended until sufficient power was obtained to render results which were clearly interpretable.

20291 (PB–90-129404/XAB) **Comments of the National Institute for Occupational Safety and Health on the Environmental Protection Agency's notice of proposed rule revision, including disposal of asbestos-containing materials removed from schools. 40 CFR Parts 61 and 763, Docket No. A-88-28.** National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). 6 Mar 1989. 6p. Available from NTIS, PC A02/MF A01.

The comments concerned the proposal of the Environmental Protection Agency (EPA) to revise rules pertaining to the disposal of asbestos containing materials from schools and the monitoring of asbestos particles in the air. In the first issue, the monitoring of emissions from asbestos, milling, manufacturing and fabricating, the EPA revisions suggested a visual inspection be made for a period of 15 seconds per day. The National Institute for Occupational Safety and Health (NIOSH) called for a more objective means of monitoring rather than using subjective visual observations. NIOSH suggested direct reading instruments such as continuous particulate monitors which are light scattering instruments. The second issue concerned the disposal of asbestos containing material such as packing, gaskets, asphalt roofing and vinyl tiles in good condition. The suggested revision stated that such material need not be removed before demolition if it cannot become friable during demolition. NIOSH commented that asbestos roofing and floor tiles, although in good condition prior to removal operations, emitted

fibers on aging and when mechanical forces were applied. NIOSH studies made during removal operations have indicated that personal and area samples exceeded both NIOSH's Recommended Exposure Level and the OSHA Permissible Exposure Limit. NIOSH urged that all such materials be considered friable under any type of demolition or removal attempt.

20292 (PB–90-129941/XAB) **Acid-rain publications by the US Fish and Wildlife Service, 1979-1989. Final report.** Villella, R.F. National Fisheries Research Center, Kearneysville, WV (USA). Acid Precipitation Section. Aug 1989. 37p. (BIOLOGICAL–80(40.28)). Available from NTIS, PC A03/MF A01.

This report is an annotated bibliography of acid-rain and related air-quality publications authored or co-authored by the U.S. Fish and Wildlife Service employees or that have been supported by Service funding. The bibliography covers 10 years of research from 1979 to 1989. Research projects have covered the effects of acidity on water chemistry, aquatic invertebrates, amphibians, fish, and waterfowl. Specific projects have addressed important fish species such as rainbow trout, brook trout, Atlantic salmon, and striped bass. In addition to lake and stream studies, wetland and some terrestrial habitat work has also been conducted. Also included in the report is research on the ecological effects of liming surface waters and surrounding watersheds.

20293 (PB–90-130048/XAB) **NIOSH (National Institute for Occupational Safety and Health) comments to DOL (Department of Labor) on the Occupational Safety and Health Administration's final rule on occupational exposure to asbestos, tremolite, anthophyllite, and actinolite.** National Inst. for Occupational Safety and Health, Rockville, MD (USA). 17 Jul 1986. 4p. Available from NTIS, PC A01/MF A01.

The comment restated the definition currently in place at NIOSH for asbestos. Concern had arisen following the issuance of an internal memorandum by Mr. Robert Glenn who was director of the Division of Respiratory Disease Studies at NIOSH. The memorandum did not change the position of NIOSH concerning the definition of asbestos as it concerns regulatory purposes. The definition remained as follows. Asbestos is defined to be chrysotile, crocidolite, and fibrous cummingtonite-grunerite including amosite, fibrous tremolite, fibrous actinolite, and fibrous anthophylite. The fibrosity of the above minerals is ascertained on a microscopic level with fibers defined as being particles with an aspect ratio of 3 to 1 or larger. At present the evidence documenting a health effect from exposure to nonfibrous cummingtonite-grunerite including amosite, fibrous tremolite, fibrous actinolite, and fibrous anthophylite was insufficient and therefore the nonfibrous forms of these minerals were excluded from the asbestos definition.

20294 (PB–90-130055/XAB) **In-depth survey report of P-I-E Nationwide, Inc., Jacksonville, Florida.** Zaebst, D.D. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Div. of Surveillance, Hazard Evaluation and Field Studies. Jul 1989. 35p. (IWS–146.13). Available from NTIS, PC A03/MF A01.

A study was conducted at the P-I-E Nationwide terminal, Jacksonville, Florida as part of a larger effort to determine whether persons exposed to diesel aerosol as part of their job continued to have an elevated risk of contracting lung cancer after controlling for tobacco smoking and to determine relative exposures to diesel aerosol among the four major presumably exposed job groups: road drivers, local drivers, dock workers, and mechanics. This dock operated 24 hours a day on three shifts. Seven tow motor trucks were located on the dock, six diesel powered, one propane powered. Sampling conducted at the site indicated that most jobs had low level exposures on the order of 6 micrograms/cubic meter (microg/m^3). Geometric mean exposures to submicrometer elemental carbon ranged from a low of 4.1 microg/m^3 in mechanics working primarily in the repair shop to 25.4 microg/m^3 in the dock workers driving diesel powered lift trucks. Only the dock workers had exposures to elemental carbon which were substantially above the concentrations determined from highway area samples. The principal source of the dock workers' exposures was diesel emissions from the fork lift trucks operated on the docks.

20295 (PB–90-130063/XAB) **NIOSH (National Institute for Occupational Safety and Health) testimony on asbestos before the Subcommittee on Labor Standards, House Committee on Education and Labor by Anthony Robbins, May 1, 1979.** Robbins, A. National Inst. for Occupational Safety and Health, Rockville, MD (USA). 1 May 1979. 18p. Available from NTIS, PC A03/MF A01.

The testimony presented information concerning the existence of asbestos related diseases among American workers. Concern over asbestos exposure became extremely important because of the vast numbers of workers in contact with the substance and also because the diseases produced through this contact, such as asbestosis, mesothelioma and lung cancer, were so very serious. While physical differences between the two broad classes of asbestos (amphiboles and serpentines) have been recognized, evidence suggested that both forms were carcinogenic. Workers were exposed during mining, milling, and transporting the mineral and while manufacturing and working with products. Studies which underscoring the widespread problem were conducted by NIOSH and other Health, Education, and Welfare supported groups in the 1960s and 1970s. Epidemiological studies identified asbestosis, a relentlessly progressive lung disease caused by inhalation of asbestos fibers, lung cancer in which the association with asbestos was first suspected in the United States in 1935, and mesothelioma, a cancer rarely found except in individuals with a history of asbestos exposure. Asbestos was the subject of the first criteria document developed by NIOSH. Future projects in the area of asbestos control and exposure prevention were listed.

20296 (PB–90-130071/XAB) **NIOSH (National Institute for Occupational Safety and Health) testimony to DOL (Department of Labor) on proposed standard for occupational exposure to inorganic arsenic by Edward J. Baier, September 8, 1976.** National Inst. for Occupational Safety and Health, Rockville, MD (USA). 8 Sep 1976. 7p. Available from NTIS, PC A02/MF A01.

The testimony addressed three technical issues concerning the arsenic (7440382) standard. These three aspects were sampling and analysis, sputum cytology, and respiratory protection. NIOSH concluded that personal sampling can be used to collect air samples to measure worker exposure to arsenic at the recommended level with a precision of about plus or minus 25% at the 95% confidence level of 0.8-micrometer pore-size filter-collected samples using atomic absorption spectroscopy. Analysis of 0.06 to 0.200 microgram samples of arsenic will yield an absorbance which may be too low for acceptable quantitative analysis. Efforts were underway to develop a reliable method for determining arsine in the desired range. Reviews of work on sputum cytology indicated that periodic exfoliative cytological study of individuals who were at an elevated risk of lung cancer assisted in identifying individuals with premalignant disease and aided in the early diagnosis of malignant disease. Concerning respiratory protection, the proposed OSHA standard for inorganic arsenic specified half mask respirators with high efficiency filters as minimum air purifying respiratory protection. The minimal respiratory protection recommended was an approved gas mask with a chin style or a front or back mounted acid gas canister with a high-efficiency particulate filter.

20297 (PB–90-500752/XAB) **INPUFF. EPA/ORD (Environmental Protection Agency/Office of Research and Development) air-quality simulation model. Model-Simulation.** Petersen, B. Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Sciences Research Lab. 1 Aug 1989. vp. Available from NTISCP D01.

The model is contained on 5 1/4-inch, double density (360K) diskettes, compatible with the IBM PC microcomputer, ready for uploading to an IBM model 3090 computer. Price includes documentation, PB–86-242468 and PB–86-242450.

INPUFF is primarily designed to model a single event during which one meteorological transition period may occur, such as going from afternoon to evening conditions. Up to 144 separate meteorological periods of the same length may be used to characterize the meteorology during the event; this provides a time resolution that ranges from minutes to an hour. The user has the option of specifying the wind field for each meteorological period at up to 100 grid locations or allowing the model to default to a homogeneous wind field....Software Description: The model is written in

the FORTRAN programming language for implementation on an IBM 3090 computer.

20298 (PB–90-500760/XAB) **PEM: Pollution Episodic Model. EPA/ORD (Environmental Protection Agency/Office of Research and Development) air-quality simulation model. Model-Simulation.** Petersen, B. Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Sciences Research Lab. 1 Aug 1989. vp. Available from NTISCP D02.

The model is contained on 5 1/4-inch, double density (360K) diskettes, compatible with the IBM PC microcomputer, ready for uploading to an IBM model 3090 computer. Price includes documentation, PB–84-232537, PB–84-164128, and PB–84-138742.

The Pollution Episodic Model (PEM) is an urban-scale (up to 50km distances) air pollution model capable of predicting short-term (1 to 24-hour) average surface concentrations and deposition fluxes of two gaseous or particulate pollutants at up to a maximum of 2500 ground-level receptors located on a 50km by 50km square receptor grid. Predictions are based on steady-state Gaussian plume assumptions, Briggs' plume rise formulations, and Pasquill-Gifford (P-G) dispersion parameters. The surface concentration and deposition flux estimates of two independent non-reactive (gaseous or particulate) pollutants or one pollutant with first-order chemical decay can be obtained as special cases of the model. Up to 300 point sources and up to 50 area sources may be included in the model inputs....Software Description: The model is written in the FORTRAN programming language for implementation on an IBM 3090 computer.

20299 (PB–90-500778/XAB) **PLUEVUE: EPA/ORD (Environmental Protection Agency/Office of Research and Development) air-quality simulation model. Model-Simulation.** Petersen, B. Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Sciences Research Lab. 1 Aug 1989. vp. Available from NTISCP D01.

The model is contained on 5 1/4-inch, double density (360K) diskettes, compatible with the IBM PC microcomputer, ready for uploading to an IBM model 3090 computer. Price includes documentation, PB–84-158302.

PLUVUE is a visibility model designed to predict transport, atmospheric diffusion, chemical conversion, optical effects, and surface deposition of point-source emissions. PLUVUE performs plume-optics calculations in two modes. In the plume-based mode, the visual effects are calculated for a variety of lines of sight and observer locations relative to the plume parcel; in the observer-based mode, the observer position is fixed and visual effects are calculated for the specific geometry defined by the positions of the observer, plume, and sun....Software Description: The model is written in the FORTRAN programming language for implementation on an IBM 3090 computer.

20300 (PB–90-500786/XAB) **PBM: Photochemical Box Model. EPA/ORD (Environmental Protection Agency/Office of Research and Development) air-quality simulation model. Model-Simulation.** Petersen, B. Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Sciences Research Lab. 1 Aug 1989. vp. Available from NTISCP D01.

The model is contained on 5 1/4-inch, double density (360K) diskettes, compatible with the IBM PC microcomputer, ready for uploading to an IBM model 3090 computer. Price includes documentation, PB–85-137164.

The PBM (Photochemical Box Model) is a simple stationary single-cell model with a variable-height lid designed to provide volume-integrated hour averages of O3 and other photochemical smog pollutants of interest for an urban area for a single day of simulation. The PBM is most appropriate for application in air-stagnation conditions with light and variable winds....Software Description: The model is written in the FORTRAN programming language for implementation on an IBM 3090 computer.

20301 (PB–90-500794/XAB) **MESOPUFF. EPA/ORD (Environmental Protection Agency/Office of Research and Development) air-quality simulation model. Model-Simulation.** Petersen, B. Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Sciences Research Lab. 1 Aug 1989. vp. Available from NTISCP D01.

The model is contained on 5 1/4-inch, double density (360K) diskettes, compatible with the IBM PC microcomputer, ready for uploading to an IBM model 3090 computer. Price includes documentation, PB–84-181775.

The MESO model is a Lagrangian variable-trajectory puff superposition model suitable for modeling the transport, diffusion, and removal of air pollutants from multiple point and area sources at transport distances beyond the range of conventional straight-line Gaussian plume models (i.e; beyond 10-50)....Software Description: The model is written in the FORTRAN programming language for implementation on an IBM 3090 computer.

20302 (PB–90-500810/XAB) **HIGHWAY-ROADWAY. EPA/ORD (Environmental Protection Agency/Office of Research and Development) air-quality simulation model. Model-Simulation.** Petersen, B. Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Sciences Research Lab. 1 Aug 1989. vp. Available from NTISCP D01.

The model is contained on 5 1/4-inch, double density (360K) diskettes, compatible with the IBM PC microcomputer, ready for uploading to an IBM model 3090 computer. Price includes documentation, PB–80-227556.

ROADWAY is a finite-difference model which solves a conservation of species equation to predict pollutant concentrations within two hundred meters of a highway. It uses surface-layer similarity theory to predict wind and eddy diffusion profiles from temperature at two heights and wind velocity upwind of the highway. A unique feature of the model is its use of vehicle wake theory. It is assumed that vehicle wakes affect the wind and turbulance fields in a linear manner with wake intensity a function of vehicle speed, downwind distance, and distance from the wake center. HIWAY is a model which computes the hourly concentrations of non-reactive pollutants downwind of roadways. It is applicable for uniform wind conditions and level terrain. Although best suited for at-grade highways, it can also be applied to depressed highways.

20303 (PB–90-500828/XAB) **UTIL-1. EPA/ORD (Environmental Protection Agency/Office of Research and Development) air-quality simulation model. Model-Simulation.** Petersen, B. Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Sciences Research Lab. 1 Aug 1989. vp. Available from NTISCP D01.

The model is contained on 5 1/4 -inch, double density (360K) diskettes, compatible with the IBM PC microcomputer, ready for uploading to an IBM model 3090 computer. Price includes documentation, PB–84-229467 and PB–83-107342.

CALMPRO, Version 1.0, is a postprocessor for MPTER, CRSTER, or ISC that reads data from an hourly concentration file (output from MPTER, CRSTER, or ISC). RUNAVG, Version 1.0, is a post-processor program for determining the highest and second-highest non-overlapping running average. RUNAVG accepts hourly concentration file input from either ISCST, TUPOS, RAM, MPTER, or CRSTER. UTMCON, Version 1.0, is a utility program to convert from latitude and longitude to UTM coordinates and vice versa. CHAVG, Version 1.0, is a post-processor program for computing running averages (averages that begin each hour and overlap) and end-to-end averages (averages that do not overlap) from hourly concentration disk or tape files.

20304 (PB–90-500836/XAB) **MPTDS Version 1.0. EPA/ORD (Environmental Protection Agency/Office of Research and Development) air-quality simulation model. Model-Simulation.** Petersen, B. Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Sciences Research Lab. 1 Aug 1989. vp. Available from NTISCP D01.

The model is contained on 5 1/4-inch, double density (360K) diskettes, compatible with the IBM PC microcomputer, ready for uploading to an IBM model 3090 computer. Price includes documentation, PB–82-215153 and PB–83-114207.

MPTDS is a modification of MPTER to explicitly account for gravitational settling and/or deposition loss of a pollutant. Surface deposition fluxes can be printed under an optional output feature. MPTDS is a multiple-point source code with an optional terrain-adjustment feature. The code is primarily based upon MPTER, which has Gaussian modeling assumptions. Execution is limited to

a maximum of 250 point sources and 180 receptors. Hourly meteorological data are required. Period of simulation can vary from 1 hour to 1 year....Software Statement: The software is written in the FORTRAN programming language for implementation on an IBM model 3090 computer. The model is distributed on a 5 1/4-inch, IBM/PC-compatible diskette.

20305 (PB–90-500844/XAB) **PAL: Point, area and line-source algorithm. EPA/ORD (Environmental Protection Agency/Office of Research and Development) air-quality simulation model (for microcomputers). Model-Simulation.** Petersen, B. Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Sciences Research Lab. 1 Aug 1989. vp. Available from NTISCP D01.

See also PB–90-500802. The software is contained on 5 1/4-inch diskettes, double density (360K), compatible with the IBM PC microcomputer. The diskettes are in the ASCII format. Price includes documentation, PB–87-168787.

PAL is a method of estimating short-term dispersion using Gaussian-plume steady-state assumptions. The algorithm can be used for estimating concentrations of non-reactive pollutants at 99 receptors for averaging times of from 1 to 24 hours and for a limited number of point, area, and line sources (99 of each type). Calculations are performed for each hour. The hourly meteorological data required are wind direction, wind speed, stability class, and mixing height. Single values of each of these four parameters are assumed representative for the area modeled. The PAL model can treat deposition of both gaseous and suspended particulate pollutants in the plume since gravitational settling and dry deposition of the particles are explicitly accounted for....Software Description: The software is written in the FORTRAN programming language for implementation on an IBM-PC microcomputer.

20306 (PB–90-500851/XAB) **APRAC3: EPA/ORD (Environmental Protection Agency/Office of Research and Development) air-quality simulation model. Model-Simulation.** Petersen, B. Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Sciences Research Lab. 1 Aug 1989. vp. Available from NTISCP D01.

The model is contained on 5 1/4-inch, double density (360K) diskettes, compatible with the IBM PC microcomputer, ready for uploading to an IBM model 3090 computer. Price includes documentation, PB–82-103763.

APRAC3 contains two recent modifications to previous versions: (1) The emission factor computation methodology has been revised to reflect recent updates, and that portion of the code that performs emissions computations has been separated from the other portions of the model to facilitate incorporation of future emission-factor methodology updates, and (2) Treating traffic links in the primary network with low vehicle miles traveled as area sources. Two local source models are available: (1) Treating pollutant behavior in a street canyon, and (2) Treating vehicle and pollutant effects at a signalized intersection. A preprocessor PREMOD2 is associated with this model.

20307 (PB–90-500869/XAB) **Data: Sample meteorological data and random numbers data file. Data file.** Petersen, B. Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Sciences Research Lab. 1 Aug 1989. vp. Available from NTISCP D01.

The model is contained on 5 1/4-inch, double density (360K) diskettes, compatible with the IBM PC microcomputer, ready for uploading to an IBM model 3090 computer.

The file CINDAY in unformatted form has been used for sample meteorological input to a number of dispersion models, such as RAM, CRSTER, MPTER, and ISC, for tests using a year's data. Since a file in unformatted or binary form cannot readily be transferred from computer to computer, the file is furnished in two parts (PT1 and PT2) in ASCII form. The program ASCBIN converts the ASCII meteorological data to unformatted (binary form). The two parts of the file should be combined together first.

20308 (PB–90-500877/XAB) **TUPOS: EPA/ORD (Environmental Protection Agency/Office of Research and Development) air-quality simulation model. Model-Simulation.** Petersen, B. Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Sciences Research Lab. 1 Aug 1989. vp. Available from NTISCP D02.

The model is contained on 5 1/4-inch, double density (360K) diskettes, compatible with the IBM PC microcomputer, ready for uploading to an IBM model 3090 computer. Price includes documentation, PB–86-181310, PB–86-181328, and PB–86-241031.

TUPOS estimates dispersion directly from fluctuation statistics at plume level and calculates plume rise and partial penetration of the plume into stable layers using vertical profiles of wind and temperature. TUPOS can be used for short-term (hours to days) impact assessment of inert pollutants from single or multiple sources and can be expected to have greatest accuracy for locations within 10 km of the source. Although TUPOS will make computations for receptors having any ground-level elevation, it is not intended as a complex-terrain model, but rather as a model for calculations over flat or gently rolling terrain. TUPOS will optionally treat buoyancy-induced dispersion but does not include building downwash, deposition, or fumigation.

20309 (PB–90-854738/XAB) **Asbestos and silicate pollution (excluding workplace pollution). March 1987-December 1989 (Citations from the NTIS data base). Report for March 1987-December 1989.** National Technical Information Service, Springfield, VA (USA). Dec 1989. 56p. Available from NTISPC N01/MF N01.

Supersedes PB–89-852701.

This bibliography contains citations concerning the occurrence and effects of asbestos and silicate pollution outside of the workplace. Topics include increased cancer risk associated with asbestos pollution, and the hazards of silica-dust inhalation and silicate effects on water resources. Included are pollutant sources, and sampling techniques and test results of analyses of indoor air samples, drinking water, and ground water for these pollutants. Asbestos and silicate pollution in the workplace and asbestos-removal technology are considered in other bibliographies. (This updated bibliography contains 78 citations, 11 of which are new entries to the previous edition.)

20310 (SCPRI-RM–1-1989) **Monthly results of measurements, Jan 1989.** Service Central de Protection contre les Rayonnements Ionisants, 78 - Le Vesinet (France). 1989. 48p. (In French). Order Number DE90752540. Available from NTIS (US Sales Only), PC A03/MF A01.

This report of the SCPRI exposes an interpretation of the principal results concerning the routine monitoring of environmental radioactivity in France: atmospheric dusts, rainwater, surface water, underground water, sewage water, drinking water, food chain (milk, vegetables, fishes), sea water around nuclear plant sites and other sites. The activities of various radioisotopes are presented in tables. This report exposes also the results of special radiation measurements resulting from the Chernobyl accident.

20311 (SCPRI-RM–2-1989) **Monthly results of measurements, Feb 1989.** Service Central de Protection contre les Rayonnements Ionisants, 78 - Le Vesinet (France). 1989. 42p. (In French). Order Number DE90752535. Available from NTIS (US Sales Only), PC A03/MF A01.

This report of the SCPRI exposes an interpretation of the principal results concerning the routine monitoring of environmental radioactivity in France: atmospheric dusts, rainwater, surface water, underground water, sewage water, drinking water, food chain (milk, vegetables, fishes), sea water around nuclear plant sites and other sites. The activities of various radioisotopes are presented in tables. This report exposes also the results of special radiation measurements resulting from the Chernobyl accident.

20312 (SCPRI-RM–3-1989) **Monthly results of measurements, Mar 1989, with supplement related to 1989 first quater.** Service Central de Protection contre les Rayonnements Ionisants, 78 - Le Vesinet (France). 1989. 63p. (In French). Order Number DE90752534. Available from NTIS (US Sales Only), PC A04/MF A01.

This report of the SCPRI exposes an interpretation of the principal results concerning the routine monitoring of environmental radioactivity in France: atmospheric dusts, rainwater, surface water, underground water, sewage water, drinking water, food chain

(milk, vegetables, fishes), sea water around nuclear plant sites and other sites. The activities of various radioisotopes are presented in tables. This report exposes also the results of special radiation measurements resulting from the Chernobyl accident.

20313 (SCPRI-RM–5-1989) **Monthly results of measurements, May 1989.** Service Central de Protection contre les Rayonnements Ionisants, 78 - Le Vesinet (France). 1989. 47p. (In French). Order Number DE90752533. Available from NTIS (US Sales Only), PC A03/MF A01.

This report of the SCPRI exposes an interpretation of the principal results concerning the routine monitoring of environmental radioactivity in France: atmospheric dusts, rainwater, surface water, underground water, sewage water, drinking water, food chain (milk, vegetables, fishes), sea water around nuclear plant sites and other sites. The activities of various radioisotopes are presented in tables. This report exposes also the results of special radiation measurements resulting from the Chernobyl accident.

20314 (SCPRI-RM–6-1989) **Monthly results of measurements, Jun 1989, with supplement related to 1989 second quarter.** Service Central de Protection contre les Rayonnements Ionisants, 78 - Le Vesinet (France). 1989. 67p. (In French). Order Number DE90752532. Available from NTIS (US Sales Only), PC A04/MF A01.

This report of the SCPRI exposes an interpretation of the principal results concerning the routine monitoring of environmental radioactivity in France: atmospheric dusts, rainwater, surface water, underground water, sewage water, drinking water, food chain (milk, vegetables, fishes), sea water around nuclear plant sites and other sites. The activities of various radioisotopes are presented in tables. This report exposes also the results of special radiation measurements resulting from the Chernobyl accident.

20315 (SCPRI-RM–7-1989) **Monthly results of measurements, Jul 1989.** Service Central de Protection contre les Rayonnements Ionisants, 78 - Le Vesinet (France). 1989. 47p. (In French). Order Number DE90752531. Available from NTIS (US Sales Only), PC A03/MF A01.

This report of the SCPRI exposes an interpretation of the principal results concerning the routine monitoring of environmental radioactivity in France: atmospheric dusts, rainwater, surface water, underground water, sewage water, drinking water, food chain (milk, vegetables, fishes), sea water around nuclear plant sites and other sites. The activities of various radioisotopes are presented in tables. This report exposes also the results of special radiation measurements resulting from the Chernobyl accident.

20316 (SCPRI-RM–8-1989) **Monthly results of measurements, Aug 1989.** Service Central de Protection contre les Rayonnements Ionisants, 78 - Le Vesinet (France). 1989. 42p. (In French). Order Number DE90752542. Available from NTIS (US Sales Only), PC A03/MF A01.

This report of the SCPRI exposes an interpretation of the principal results concerning the routine monitoring of environmental radioactivity in France: atmospheric dusts, rainwater, surface water, underground water, sewage water, drinking water, food chain (milk, vegetables, fishes), sea water around nuclear plant sites and other sites. The activities of various radioisotopes are presented in tables. This report exposes also the results of special radiation measurements resulting from the Chernobyl accident.

20317 (SCPRI-RM–9-1988) **Monthly results of measurements, Sep 1988, with supplement related to 1988 third quarter.** Service Central de Protection contre les Rayonnements Ionisants, 78 - Le Vesinet (France). 1988. 62p. (In French). Order Number DE90752537. Available from NTIS (US Sales Only), PC A04/MF A01.

This report of the SCPRI exposes an interpretation of the principal results concerning the routine monitoring of environmental radioactivity in France: atmospheric dusts, rainwater, surface water, underground water, sewage water, drinking water, food chain (milk, vegetables, fishes), sea water around nuclear plant sites and other sites. The activities of various radioisotopes are presented in tables. This report exposes also the results of special radiation measurements resulting from the Chernobyl accident.

20318 (SCPRI-RM–9-1989) **Monthly results of measurements, Sep 1989, with supplement related to 1989 last quarter.** Service Central de Protection contre les Rayonnements Ionisants, 78 - Le Vesinet (France). 1989. 70p. (In French). Order Number DE90752541. Available from NTIS (US Sales Only), PC A04/MF A01.

This report of the SCPRI exposes an interpretation of the principal results concerning the routine monitoring of environmental radioactivity in France: atmospheric dusts, rainwater, surface water, underground water, sewage water, drinking water, food chain (milk, vegetables, fishes), sea water around nuclear plant sites and other sites. The activities of various radioisotopes are presented in tables. This report exposes also the results of special radiation measurements resulting from the Chernobyl accident.

20319 (SCPRI-RM–10-1988) **Monthly results of measurements, Oct 1988.** Service Central de Protection contre les Rayonnements Ionisants, 78 - Le Vesinet (France). 1988. 43p. (In French). Order Number DE90752536. Available from NTIS (US Sales Only), PC A03/MF A01.

This report of the SCPRI exposes an interpretation of the principal results concerning the routine monitoring of environmental radioactivity in France: atmospheric dusts, rainwater, surface water, underground water, sewage water, drinking water, food chain (milk, vegetables, fishes), sea water around nuclear plant sites and other sites. The activities of various radioisotopes are presented in tables. This report exposes also the results of special radiation measurements resulting from the Chernobyl accident.

20320 (SCPRI-RM–10-1989) **Monthly results of measurements, Oct 1989.** Service Central de Protection contre les Rayonnements Ionisants, 78 - Le Vesinet (France). 1989. 46p. (In French). Order Number DE90752543. Available from NTIS (US Sales Only), PC A03/MF A01.

This report of the SCPRI exposes an interpretation of the principal results concerning the routine monitoring of environmental radioactivity in France: atmospheric dusts, rainwater, surface water, underground water, sewage water, drinking water, food chain (milk, vegetables, fishes), sea water around nuclear plant sites and other sites. The activities of various radioisotopes are presented in tables. This report exposes also the results of special radiation measurements resulting from the Chernobyl accident.

20321 (SCPRI-RM–11-1988) **Monthly results of measurements, Nov 1988.** Service Central de Protection contre les Rayonnements Ionisants, 78 - Le Vesinet (France). 1988. 43p. (In French). Order Number DE90752538. Available from NTIS (US Sales Only), PC A03/MF A01.

This report of the SCPRI exposes an interpretation of the principal results concerning the routine monitoring of environmental radioactivity in France: atmospheric dusts, rainwater, surface water, underground water, sewage water, drinking water, food chain (milk, vegetables, fishes), sea water around nuclear plant sites and other sites. The activities of various radioisotopes are presented in tables. This report exposes also the results of special radiation measurements resulting from the Chernobyl accident.

20322 (SCPRI-RM–12-1988) **Monthly results of measurements, Dec 1988, with supplement related to 1988 last quarter.** Service Central de Protection contre les Rayonnements Ionisants, 78 - Le Vesinet (France). 1988. 62p. (In French). Order Number DE90752539. Available from NTIS (US Sales Only), PC A04/MF A01.

This report of the SCPRI exposes an interpretation of the principal results concerning the routine monitoring of environmental radioactivity in France: atmospheric dusts, rainwater, surface water, underground water, sewage water, drinking water, food chain (milk, vegetables, fishes), sea water around nuclear plant sites and other sites. The activities of various radioisotopes are presented in tables. This report exposes also the results of special radiation measurements resulting from the Chernobyl accident.

20323 (SFB-210/A–42) **Work and result report of Special Research Area 210 for the years 1985-1987.** Friedrich, R. (ed.). Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich

210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke. Mar 1988. 325p. (In German). Available from Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke. Available from Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke.

The Special Research Area (SFB) 210 'Flow mechanics basis of dimensions for buildings' has set itself the target of expanding the basic knowledge on the interaction between flow and buildings to create improved or new bases for dimensions. The part projects of SFB 210 in the form of short reports are arranged in the following project areas: (a) Investigation of basic flow; (b) Flow around and through buildings; (c) Flow-induced forces and vibration; (d) Physical, chemical and biological reactions affected by flow; (e) Development of new measurement processes. (orig./KW).

20324 (SFB-210/A–42, pp. 13-25) **Numerical simulation of stratified flows around and over obstacles.** Fiedler, F.; Dorwarth, G.; Emeis, S. Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke. Mar 1988. (In German). In *Work and result report of Special Research Area 210 for the years 1985-1987.* Available from Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke. Available from Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke.

In this part project, one is concerned with numerical modelling of the mean wind and the turbulence around and over meso-scale obstacles (of the order of magnitude 10^2 to 10^4 m) and with parametricising the pressure and flow resistance in different atmospheric strata. For parametricising, the resistance is to be calculated with high spatial resolution at individual obstacles and groups of obstacles (mountains and valleys) and to be described depending on the different parameters. With stable atmospheric stratification, the proportion of the individual components (shape and wave resistance) of the total resistance is of interest. (orig./KW).

20325 (SFB-210/A–42, pp. 27-39) **Experimental study of atmospheric flow influenced by orographic structures and buildings.** Fiedler, F.; Hoeschele, K.; Heldt, K. Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke. Mar 1988. (In German). In *Work and result report of Special Research Area 210 for the years 1985-1987.* Available from Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke. Available from Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke.

The part project A2 of SFB 210 set itself the target of measuring the flow conditions on natural and artificial obstacles in the atmospheric boundary layer experimentally, in order to create a set of data which makes comparison with wind tunnel measurements and with the results of numerical simulation possible. The investigations which were concentrated on a simple obstacle, a high water dam 3.5 m tall, refer to the modification of the flow by the obstacle, regarding the mean wind profile, the turbulent parameters (turbulent flows, kinetic energy), the behaviour of individual eddy elements. The direction of incoming flow, i.e.: the effective half width of the obstacle and the thermal stratification of the incoming flow must be taken into account as independent parameters. The main point of the investigations, for reasons of comparability with similar measurements in the wind tunnel and in nature, was the wind profile directly above the top point of the obstacle. In considering the fluctuation parameters, the windward and particularly the leeward area, must be included. (orig.).

20326 (SFB-210/A–42, pp. 41-56) **Wind tunnel modelling of the air flow around orographic obstacles and buildings.** Plate, E.J.; Baechlin, W.; Bloechl, B.; Rau, M. Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke. Mar 1988. (In German). In *Work and result report of Special Research Area 210 for the years 1985-1987.* Available from Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke. Available from Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke.

The task of the part project A3 in the present phase consists of the development, the design and the construction of a thermal stratified wind tunnel. For this reason, the chapter on 'knowledge' is mainly concentrated on work which was published on the subject of 'Wind tunnel modelling of stratified flow'. The chapters on 'applied methods' and 'results' are combined and contain in the first place, the procedure in wind tunnel planning, the dimensioning of the wind tunnel and the description of the most important technical details. The chapter on 'Comparison with work outside the special research area' mentions further work on the subject of 'Wind tunnel modelling of stratified flow' which was carried out during this phase. In the chapter on 'open questions', the physical and technical problems which must be solved for success in attaining the set targets, are briefly discussed. (orig./KW).

20327 (SFB-210/A–42, pp. 57-69) **Calculation of non-steady effects in flow around buildings.** Rodi, W.; Schoenung, B.; Majumdar, S.; Franke, R. Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke. Mar 1988. (In German). In *Work and result report of Special Research Area 210 for the years 1985-1987.* Available from Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke. Available from Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke.

The aim of the project is producing a non-steady state three-dimensional process for calculating turbulent flow around buildings. The process must be non-steady state, as in a steady state calculation, important physical processes cannot be taken into account and therefore steady state methods of calculation only have a limited value as the basis for dimensioning. In the application period, a process should first be developed and extensively tested for two-dimensional non-steady state flow, using the example of eddy separation on cylindrical (circular and square) buildings. Laminar eddy separation should be calculated first and the first numerical test runs should examine the interaction between numerical diffusion and numerical instabilities. As no detailed velocity fields were available from experimental investigations for laminar eddy separation, the comparison had to be limited to calculated and measured values. (orig./KW).

20328 (SFB-210/A–42, pp. 71-88) **Simulation of flow processes at buildings.** Frank, W.; Mauch, H. Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke. Mar 1988. (In German). In *Work and result report of Special Research Area 210 for the years 1985-1987.* Available from Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke. Available from Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke.

In the experimental part, the same time mean ground boundary layer profile is produced in the wind tunnel with at least two different turbulence structures. The details of these profiles are determined by hot wire measurements. In this boundary layer flow, different rectangular models of buildings are then examined. By means of pressure sensors, the time mean pressure distributions and pressure variations in the windward area of the models and in the sub-pressure areas in the separation area of the flow can be determined. One can also make good qualitative predictions from numerical calculations. The Navier-Stokes equations describing the flow problem are formulated in the steady state two-dimensional incompressible form by means of finite differences. The numerical results are compared with the pictures experimentally obtained in the wind tunnel, in order to check the accuracy of the process of calculation used. (orig./KW).

20329 (SFB-210/A–42, pp. 89-102) **Vibrations of buildings with flow below and around them.** Naudascher, E.; Thang, N.D.;

Callander, S.; Rao, B.C.S.; Ziada, S.; Hristov, J. Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke. Mar 1988. (In German). In *Work and result report of Special Research Area 210 for the years 1985-1987.* Available from Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke. Available from Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke.

Experimental methods and means of making flow visible are to the fore. In particular, experiments with (I) free and (II) forced vibrations of the building to be examined must be carried out. While the first method gives direct information on conditions producing dangerous vibration, the second supplies detailed information on the exciting mechanism. (orig./KW).

20330 (SFB-210/A–42, pp. 103-117) **Loading of cylindrical buildings in natural wind and their modelling in the wind tunnel.** Treiber, B.; Plate, E.J.; Menacher, F.; Baechlin, W.; Maier-Erbacher, J. Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke. Mar 1988. (In German). In *Work and result report of Special Research Area 210 for the years 1985-1987.* Available from Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke. Available from Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke.

The main point of the project is the investigation of wind-induced loading on narrow buildings which are situated in disturbed boundary layers due to topography or local circumstances. Measurements are made on a natural building for this purpose. In order to be able to compare the results achieved with undisturbed conditions as regards the spatial/temporal build-up of turbulence and pressure correlations, measurements were made on the 160 meter tall meteorological tower in Gundremmingen and these were evaluated. In parallel with this, model measurements were made in order to obtain basic information on the vertical correlation structure of the turbulence and the pressure heads important for longitudinal loads. (orig.).

20331 (SFB-210/A–42, pp. 119-142) **Pressure and force coefficients of rectangular bodies in turbulent boundary layer flows.** Plate, E.J.; Friedrich, R.; Maier-Erbacher, J.; Beelitz, W.D.; Wacker, J. Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke. Mar 1988. (In German). In *Work and result report of Special Research Area 210 for the years 1985-1987.* Available from Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke. Available from Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke.

The mean and fluctuating wind forces acting on the total building are decisive for the dimensioning of the foundations of a building. For the dimensioning of individual components such as facade elements, for example, the forces on the component surfaces, distributions of local pressures, local pressure and suction peaks, spatial pressure correlations and for permanent loads, the frequencies and amplitudes of fluctuating pressures are important. The exact knowledge of the above-mentioned load parameters is of great importance in order to meet the requirements of safe and economical dimensioning. (orig./KW).

20332 (SNV–3597) **Atmospheric trace metals: Workshop on their collection and analysis.** Statens Natuurvaardsverk, Solna (Sweden). 1989. 82p. (CONF-8903193–Summ.: Workshop on atmospheric trace metals, Oersundsbro (Sweden), 13-15 Mar 1989). Order Number DE90748541. Available from NTIS (US Sales Only), PC A05/MF A01.

There were 30 participants from 9 countries. The program was divided into 5 areas: 1. General lectures on atmospheric trace metals. 2. Results from ongoing or completed intercalibrations. 3. Atmospheric mercury. 4. Presentation of ongoing research and monitoring programs within HELCOM and PARCOM countries (evening poster session). 5. Field trips to the SNV air chemistry laboratory, proposed site for the intercalibration exercise of precipitation samples, and to the Department of Meteorology, University of Stockholm (MISU) Air Chemistry Laboratories. Presentations of intercalibration results indicated that quality control must be a continuous function of all laboratories and that funding agencies must make allowances for the participation in extended intercalibrations. In addition, mercury, while considered an important environmental contaminant, is not receiving the attention it deserves.

20333 (TPR-NS–29-No.3, pp. 318-326) **Data-base construction for a computerized radiological-risk investigation system.** Hively, L.M.; Nyquist, J.E.; Bledsoe, J.L.; Sjoreen, A.L. Oak Ridge National Lab., TN (USA). Jul 1988. In *Nuclear Safety: Volume 29, No. 3: Technical progress review.* Order Number DE88008738. Available from GPO7.50.

Oak Ridge National Laboratory developed a Computerized Radiological Risk Investigation System (CRRIS) to assess chronic exposures from atmospheric radionuclide releases. Previously, CRRIS population and agricultural data were tabulated on $\frac{1}{2}^{\circ}$ square grid cells, which resulted in anomalies, such as population in water bodies and agriculture in cities. These difficulties were overcome by using Thiessen polygons to apportion an area to individual census enumeration districts and exclude population from unpopulated areas (e.g., large water bodies). This article discusses the data base construction using examples from Tennessee and Pennsylvania. 10 refs., 5 figs.

20334 (UCRL–101503) **Predicting human exposure from multiple pathways: An integrated approach.** McKone, T.E.; Daniels, J.I. Lawrence Livermore National Lab., CA (USA). Nov 1989. 13p. Sponsored by U.S. DOE Defense Programs; Environmental Protection Agency; State of California. DOE Contract W-7405-ENG-48. (CONF-8911166–1: Total exposure assessment methodology Environmental Protection Agency symposium, Las Vegas, NV (USA), 27-30 Nov 1989). Order Number DE90006923. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Human populations are in continuous contact with varying amounts of environmental pollutants in food, water, and air. Managing the health and environmental risks related to environmental pollutants requires an integrated model for estimating environmental transport and human exposure. We developed methods and supporting data for deriving pathway-exposure factors (PEFs) that link chemical concentrations in multiple environmental media to human exposure. Each PEF numerically translates a chemical concentration in each of the primary environmental media (air, water, and soil) into population exposure rates (in mg/kg-d) for specific routes of exposure. Incorporated into each PEF is information on human physiology and life style, as well as data describing pollutant behavior in food chains or in microenvironments, such as indoor air. We developed PEFs for nine exposure pathways (inhalation; water intake; fruit and vegetable, and grain ingestion; meat, milk, and fish consumption; soil ingestion; and dermal absorption) associated with five environmental media–atmospheric gases and particles; soil; and ground and surface water. We discuss here the matrix of PEFs that link these exposure pathways and environmental media and describe the human, animal, and environmental data needed to derive the respective PEFs. Using examples for exposure to contaminants in potable water and to contaminants transferred from air to food, we consider the completeness of current exposure models and the treatment of uncertainty in exposure estimates. Results indicate that risk managers should consider the potential for multiple results indicate that risk managers should consider the potential for multiple pathways, avoid risk assessments derived from single value estimates, be aware of the uncertainty in risk estimates, and include this awareness in their decisions. 18 refs., 3 figs.

20335 **Prediction of rainwater acidity using trace element concentrations.** Vong, R.J. (Univ. of Washington, Seattle (USA)); Peterson, R.E. *Preprints of Papers Presented at National Meeting, Division of Water, Air and Waste Chemistry, American Chemical Society (USA),* 28(2): 30-33 (Sep 1988). DOE Contract AC06-76RL01830. (CONF-8909230–: 44. lecture meeting of Deutsche

Gesellschaft fuer Fettwissenschaft e.V., Trier (Germany, F.R.), 12-15 Sep 1989).

It is of interest to be able to estimate the contribution of an anthropogenic emission source to downwind rainwater chemistry. The authors here consider the closure of a large copper smelter which operated in a region where background and other emission sources should contribute smaller amounts of atmospheric sulfur than the smelter. An additional simplification existed in that meteorology associated with rain was relatively well known and consistent. A field experiment was conducted in the winters of 1985 and 1986 to collect rainwater at sites upwind and downwind of the Tacoma, Washington smelter. The smelters SO_2 emissions, their conversion to SO_4= via three oxidants (O_3, H_2O_2, and O_2 - Fe catalyzed reactions), diffusion, transport, and aerosol/gas scavenging previously have been estimated while adjusting model parameters until the predictions fit the rainwater data. To take advantage of the unique experimental design afforded by the closure of the smelter, statistical analysis was performed on NO_3-, SO_4(xs)= (excess of seasalt), and pH data; analysis of variance (ANOVA) confirmed that the smelter had a significant ($p < .01$) influence on rainwater pH and SO_4(xs). The analysis presented here extends the ANOVA by applying a multivariate regression technique to new data for trace element concentrations for the same rain samples. To predict rainwater acidity, they derive fingerprints from trace element data, identify a source or process related to that fingerprint, and compare the predicted contributions for pre- and post- closure samples.

20336 Evaluation of springtime nitrogen oxide and oxidant data from a suburban/rural northeast USA surface site. Tanner, R.L. (Brookhaven National Lab., Upton, NY (USA)); Roberts, J.M.; Gaffney, J.S.; Sisterson, D.L. *Preprints of Papers Presented at National Meeting, Division of Water, Air and Waste Chemistry, American Chemical Society (USA),* 28(2): 53-58 (Sep 1988). DOE Contract AC02-76CH00016. (CONF-8909232--: 8. Japan - United States Governmental conference on solid waste management, Honolulu, HI (USA), 6-7 Sep 1989).

Measurements of NO_y (defined as NO + NO_2 + HNO_3 + peroxyacetyl nitrate + other gaseous organic nitrates), its oxidation products (e.g., nitric acid and peroxyacyl nitrates (PANs)), and related oxidant concentrations have been conducted for a significant period of time in only a few locations. For semi-rural locations in the Northeast USA, continuous or hourly data are relatively scarce, such that the climatology and pollution roses as related to sources are not widely available, particularly in transition (spring and fall seasons). Measurements of PAN and its seasonal and diurnal relation to NO_y have been reported for urban sites, regional locations and, in a few cases, remote sites. These measurements, recently reviewed by Roberts (1988), are particularly critical in evaluations of the nitrogen oxide cycle in the global troposphere. Nitric acid concentrations have been widely measured and compared in some cases with NO_y and total nitrate (HNO_3 + particulate NO_3^- + PAN) data for the purpose of evaluating seasonal and air mass trajectory dependencies. There are only a few studies in which PAN and HNO_3 data over significant time periods have been reported and related to seasonally varying NO_y and oxidant levels at a sampling location. In the absence of direct, ambient measurements of NO_3 and N_2O_5, these studies also have great significance in determining the role of gas-phase vs. aqueous-phase processes in generating secondary acidic species for incorporation into hydrometeors.

20337 Nitrogen dioxide and pan measurements in Albuquerque, NM. Gaffney, J.S. (Los Alamos National Lab., NM (USA)); Prestbo, E.; Franzblau, E.; Popp, C.J. *Preprints of Papers Presented at National Meeting, Division of Water, Air and Waste Chemistry, American Chemical Society (USA),* 28(2): 83-84 (Sep 1988). (CONF-8909232--: 8. Japan - United States Governmental conference on solid waste management, Honolulu, HI (USA), 6-7 Sep 1989).

It is increasingly apparent that urban, regional, and global scale environmental problems are coupled and cannot be arbitrarily separated. Most all of the major western cities now suffer from brown cloud problems. The degradation of visibility from the interactions of aerosols and gases with the incoming solar radiation has been the major focus of the research on these problems. They authors are just beginning to appreciate that these problems are coupled with oxidant issues, as well. For example, secondary aerosols are produced from oxidation reactions involving gas phase species, as well as aqueous oxidation reactions and will contribute to the visibility degradation. This work presents data for NO_2 and peroxyacetyl nitrate levels measured in Albuquerque, NM during the winter of 1988 using correlation spectrometry and gas chromatography/electron capture detection, respectively. These data indicate that the photochemical oxidation of sulfur dioxide and other materials will contribute secondary aerosols to the urban environment, even in the wintertime. Aqueous production on wet aerosols and in fogs and clouds may also be important as peroxide production will be coupled to the gas and aqueous phases. In many of the mountain states, the effect of changing albedo needs to be taken into account when dealing with these situations, particularly for those urban centers where snow cover can be appreciable in the winter. Various control strategies will be discussed in terms of the coupled oxidative gas phase and aerosol phase chemistry and physics. The need for simultaneous aerosol and gas phase measurements in brown cloud studies will be addressed.

20338 Characterization of a calibration source and gas chromatographic system for the measurement of ambient PAN (peroxyacetyl nitrate). Roberts, J.M. (Brookhaven National Lab., Upton, NY (USA)); Fajer, R.W.; McIntire, D.M. *Preprints of Papers Presented at National Meeting, Division of Water, Air and Waste Chemistry, American Chemical Society (USA),* 28(2): 85-87 (Sep 1988). DOE Contract AC02-76CH00016. (CONF-8909232--: 8. Japan - United States Governmental conference on solid waste management, Honolulu, HI (USA), 6-7 Sep 1989).

Peroxyacetyl nitrate (PAN) is an important component of atmospheric odd-nitrogen (NO_y) chemistry. Recent studies have shown PAN to often be present at concentrations several times those of NO_x (NO + NO_2), and PAN often comprises a major fraction of atmospheric NO_y. Such studies rely in part on the accurate measurement of PAN. Field measurement of PAN is most often accomplished by gas chromatography (GC) with electron capture detection (ECD), which requires a calibration method that is portable, stable with time, and accurate. This has proven to be a challenging problem due to the difficulties inherent in producing and storing this thermally stable species. A field-portable calibration source and GC/ECD system for the measurement of PAN is described here.

20339 Peroxyacetyl nitrate (PAN) measurements at a remote site in New Mexico. Prestbo, E. (Univ. of Washington, Seattle (USA)); Gaffney, J.S. *Preprints of Papers Presented at National Meeting, Division of Water, Air and Waste Chemistry, American Chemical Society (USA),* 28(2): 90-91 (Sep 1988). (CONF-8909232--: 8. Japan - United States Governmental conference on solid waste management, Honolulu, HI (USA), 6-7 Sep 1989).

Photochemical oxidants are not limited to the criteria pollutant, ozone. Peroxyactyl nitrate (PAN) is probably one of the better known non-criteria oxidants. PAN was originally referred to as compound X, as it caused a unique type of plant damage to numerous crops in southern California. PAN was associated with Los Angeles photochemical smog and ozone in the late 1950s and 60s. It should not be confused with X-agent which has also been associated with photochemical oxidants. PAN has been found to be an important means of transporting NOx in remote regions. This is due to its rather long atmospheric lifetime. It reacts slowly with OH radical, is photochemically stable, and has a low water solubility. Its principal loss is due to unimolecular decomposition. The authors have been making ozone, NO, NO^2, and PAN measurements at a remote site near Los Alamos, New Mexico for an extended period of time. An automated gas chromatograph equipped with an electron capture detector is used to make the PAN measurements. Diffusion tubes with PAN/n-tridecane solutions are used to calibrate the instrument. Typical PAN data obtained at the sight are presented. The collected PAN and oxidant data are examined, and have been modeled to determine the possible concentrations of peracetic acid and methyl hydroperoxide in remote air. These studies are discussed in light of their possible implications for peroxide contributions to environmental impacts and aqueous chemistry reactions.

20340 Factors governing the concentration of hydrogen peroxide in storm inflow air. Kleinman, L.I. (Brookhaven National

Lab., Upton, NY (USA)); Leslie, A.C.D. *Preprints of Papers Presented at National Meeting, Division of Water, Air and Waste Chemistry, American Chemical Society (USA),* 28(2): 99-102 (Sep 1988). DOE Contract AC02-76CH00016. (CONF-8909232–: 8. Japan - United States Governmental conference on solid waste management, Honolulu, HI (USA), 6-7 Sep 1989).

Aqueous phase reaction of SO_2 with H_2O_2 is a major source of sulfate and acidity in precipitation in industrialized regions. Reaction between SO_2 and H_2O_2 is rapid compared with relevant atmospheric residence times. Under many conditions, the total amount of SO_2 oxidized to H_2so_4 can be limited by the amount of H_2O_2 present in the atmosphere. The DOE-sponsored PRECP (PRocessing of Emissions by Clouds and Precipitation) program has included modeling and field studies directed at determining the abundance of H_2O_2 and the atmospheric factors influencing its concentration. Photochemical calculations indicate that formation of H_2O_2 can, for a set of conditions characterized primarily by low NO_x concentration, be understood in terms of a requirement that sources and sinks of free radicals in the atmosphere be in balance. A causal relation between H_2O_2 and H_2O is predicted on the basis that OH radical production from O_3 photolysis is proportional to the concentration of water vapor. Concurrent atmospheric measurements of H_2O_2 and H_2O at mid-troposphere altitudes (June 1987; near Columbus, Ohio) indicate a relation qualitatively similar to that predicted.

20341 Global atmospheric chemistry and its role in climate change. Wuebbles, D.J. (Lawrence Livermore National Lab., CA (USA)). *Preprints of Papers Presented at National Meeting, Division of Water, Air and Waste Chemistry, American Chemical Society (USA),* 28(2): 211-214 (Sep 1988). DOE Contract W-7405-ENG-48. (CONF-8909235–: Technical committee meeting on fundamental aspects of corrosion of zirconium-based alloys in water reactor environments, Portland, OR (USA), 11-15 Sep 1989).

The direct radiative forcing on the atmosphere that results from any given amounts of CO_2 and other trace gases is generally well understood. However, the magnitude of climate change that could result is still highly uncertain, largely due to remaining uncertainties in climate feedback processes. In addition to direct radiative effects of surface-emitted gases, there are indirect effects on climate that need to be considered. Atmospheric chemistry plays a key role in the determination of many of these effects. The actual atmospheric composition of the greenhouse gases will depend not only on natural and anthropogenic surface emissions, but also on any atmospheric chemical processes affecting their concentrations and distributions. These photochemical processes are often coupled and nonlinear. Because of this, the net climatic impact of changes mediated by photochemistry tends to be specific to the detailed scenario assumed for trace gas abundance and emission trends.

20342 Chemistry of CO_2 in the ocean. Tsunghung Peng (Oak Ridge National Lab., TN (USA)); Taro Takahashi. *Preprints of Papers Presented at National Meeting, Division of Water, Air and Waste Chemistry, American Chemical Society (USA),* 28(2): 223-225 (Sep 1988). DOE Contract AC05-84OR21400. (CONF-8909235–: Technical committee meeting on fundamental aspects of corrosion of zirconium-based alloys in water reactor environments, Portland, OR (USA), 11-15 Sep 1989).

Atmospheric CO_2 concentration is controlled predominantly by the ocean because the ocean is the earths largest active carbon reservoir (e.g. 50 times as large as the atmosphere). Over the past century, anthropogenic CO_2 released into the atmosphere has led to a steady rise in the atmospheric CO_2 level, which has increased at a rate of about 1 ppm per year during the last two decades. Without oceanic uptake of CO_2, the increase would be much higher. To predict the atmospheric CO_2 increase in the next 50 years, the role of the ocean in the global carbon cycle must be understood.

20343 Biogeochemistry of CO_2 in carbon cycle models: Interactions of C, N, and P in the biosphere. King, A.W. (Oak Ridge National Lab., TN (USA)); O'Neill, R.V. *Preprints of Papers Presented at National Meeting, Division of Water, Air and Waste Chemistry, American Chemical Society (USA),* 28(2): 226-228 (Sep 1988). DOE Contract AC05-84OR21400. (CONF-8909235–: Technical committee meeting on fundamental aspects of corrosion of zirconium-based alloys in water reactor environments, Portland, OR (USA), 11-15 Sep 1989).

An understanding of the interactions and feedbacks between global biogeochemical cycles may be crucial to their ability to forecast future concentrations of atmospheric CO_2 and other greenhouse gases. The authors ability to predict the direct and indirect effects of future atmospheric concentrations may also depend on an understanding of interactive biogeochemical cycles. However, most models used to forecast future levels of atmospheric CO_2 and to predict their effects do not include interactions with other biogeochemical cycles. Here they begin to explore the consequences of those interactions with a model of linked global C, N, and P cycles. The model is a globally aggregated compartment model with annual resolution. Three subsystems are simulated: a terrestrial component, a freshwater component, and a marine component, and the model tracks the organic and inorganic phase of each element within and between each component or subsystem. The model focuses on the biotic interactions between the global cycles of C, N, and P. Because of these interactions the model involves a nonlinear representation of biomass production and decomposition fluxes, and this nonlinearity admits the possibility of complex non-linear dynamics. They describe the structure and parameterization of their model, discuss their nonlinear formulation of interactions between the cycles, and address the question of whether the nonlinear interactions tend to stabilize or destabilize the global system. They explore this question by comparing model perturbations with and without the N and P limitation of the carbon cycle. Their results indicate that the interactions between the C, N, and P cycles tend to dampen or constrain the systems response to perturbations of the carbon cycle.

20344 Method and apparatus for reducing radiation exposure through the use of infrared data transmission. Austin, F.S.; Hance, A.B. To Dept. of Energy, Washington, DC. USA Patent 4,864,652. 5 Sep 1989. Filed date 21 Jan 1988. USA Patent Application 7-146,627. Int. Cl. H04B 9/00. vp. Available from Patent and Trademark Office, Box 9, Washington, DC 20232.

This patent describes a method of communicating information from a relatively hazardous environment to a relatively safe environment. It comprises the steps of: synchronizing information; transmitting a digital information signal; summing the digits of the byte sequence in both the transmitting means and the receiving means; generating and transmitting a checksum byte; determining whether or not the received checksum byte equals the sum of the digits received from the transmitting means; displaying the received digital information signal; discarding the received information if the checksum byte does not equal the sum of the digits received; and recycling the receiving means to be responsive to a subsequent synchronous start signal from the transmitting means.

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Refer also to citation(s) 19284, 19285, 19330, 19336, 19343, 19349, 19354, 19370, 19376, 19381, 19406, 19410, 19418, 19423, 19425, 19426, 19427, 19428, 19429, 19430, 19431, 19432, 19433, 19434, 19435, 19438, 19633, 19654, 19691, 19692, 19981, 20266, 20267, 20268, 20274, 20310, 20311, 20312, 20313, 20314, 20315, 20316, 20317, 20318, 20319, 20320, 20321, 20322, 20334, 20343, 20379, 20388, 20391, 20397, 20456, 20463, 20466, 20481, 20483

20345 (AECL–9337) **Evaluation of backfill materials for a shallow-depth repository.** Buckley, L.P.; Arbique, G.M.; Tosello, N.B.; Woods, B.L. Atomic Energy of Canada Ltd., Chalk River, ON (Canada). Chalk River Nuclear Labs. Nov 1986. 19p. (CONF-8609350–:). Order Number DE90617489. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The focus of laboratory research effort on the disposal of low- and intermediate-level radioactive waste is to determine what conditions will dominate and which engineered barriers will be most effective for the retention of radionuclides. Initial studies have concentrated on the evaluation of a flooded repository and the assessment of backfill materials suitable for the adsorption of radioactivity, yet permeable enough to allow excess water to pass through the repository and into the underlying water table. Both physical and adsorption studies have been performed. Based on

these preliminary experiments, it is felt that a mixture of 10 wt% clay and the remainder sand would satisfy the above criteria. Since both are available within the Ottawa Valley, they also have the added advantage of being more cost effective to use than imported materials.

20346 (ANL/ACL–89/1) **A comparison of PCB/pesticide quantitation using packed vs. Megabore columns.** Hansen, M.C.; Schneider, J.F.; Erickson, M.D. Argonne National Lab., IL (USA). Dec 1989. 22p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. Order Number DE90005812. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

At Argonne National Laboratory (ANL), we are participating in the DOE Environmental Survey Program, which uses Environment Protection Agency (EPA) Contract Laboratory Program (CLP) methods for analysis of environmental samples. For PCB/pesticides, the CLP method requires gas chromatograph/electron capture detector analysis of a primary and secondary column. Currently, samples undergo quantitative analysis on an EPA-required packed column, while confirmation of retention time is on a megabore column. Megabore columns yield higher resolution, which aids in PCB/pesticide identification and improves quantitation. Megabore columns are used in the CLP method for quantitation only after validation of results with the required packed column. To compare the results from both columns, we quantitatively analyzed over 100 water and soil/sediment samples for PCB/pesticides on packed and megabore columns. This study found a wide variance between megabore columns and packed column quantitation, and concluded that no on the type of column was more accurate or precise in PCB/pesticide identification. 4 refs., 6 figs., 7 tabs.

20347 (Beitraege–1/89) **Radioactivity monitoring network: Measurements 1987.** Bundesministerium fuer Gesundheit und Umweltschutz, Vienna (Austria). 1989. 212p. (In German). Order Number DE90617487. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

Four papers are presented: radionuclide concentration measurement in aerosols, surface water and the wastes of the Vienna Central Clarification Plant respectively, and on tritium in Austrian lakes and rivers. (qui).

20348 (BFE-R–89-03) **Radioecological investigations in the food-chain air-soil-vine-wine. Pt. 2. Final report.** Wagner, A. (Bundesforschungsanstalt fuer Ernaehrung, Karlsruhe (Germany, F.R.). Zentrallaboratorium fuer Isotopentechnik). Bundesforschungsanstalt fuer Ernaehrung, Karlsruhe (Germany, F.R.). Oct 1989. 205p. (In German). Contract BMI St.Sch. 746. Available from Bundesforschungsanstalt fuer Ernaehrung, Karlsruhe (Germany, F.R.). Available from Bundesforschungsanstalt fuer Ernaehrung, Karlsruhe (Germany, F.R.).

This Part 2 presents all of the results, including the harvest of 1986 and 1987; it thus describes the consequences of the Chernobyl accident. H-3, C-14, Sr-90 and Cs-137 were determined in soil, vine leaves, grapes and wine at different locations. In some of the samples Cs-134, K-40 and Ra-226 were also measured. Site-specific transfer factors were calculated for Sr-90 and for the Cs radionuclides. The mean content of Cs-137 before Chernobyl (after Chernogyl) was about 4 (9) Bq/kg dry matter in soil (top 30 cm), 0.07 (3) Bq/kg fresh matter in leaves, 0.02 (0.4) Bq/kg FM in grapes, and 0.008 (0.9) Bq/l in wine. As comapred to 1986 distinctly lower levels were found in leaves, grapes and wine from 1987. The content of Cs-134 was about half that of Cs-137 in 1986. Due to its shorter half-life Cs-134 had fallen below detection limit in many of the 1987 samples. Mean Sr-90 levels were 1-2 Bq/kg in soil and in leaves (dry matter and fresh matter, respectively), 19-56 mBq/kg in grapes, and 3-11 mBq/l in wine. Samples obtained in the fall of 1986 showed no increase of Sr-90 in soil and leaves, whereas a slight increase was found in grapes and wine as a consequence of Chernobyl. Site-specific influences such als soil parameters, climate, cultivation, vinification and differences between years had no pronounced effects on transfer factors. No influence of the nuclear power station Neckarwestheim has been found in any of the radionuclides. (orig./HP).

20349 (BNL–43145) **Perfluorocarbon tracer tagging of drilling muds for the assessment of sample contamination.** Senum, G.I.; Dietz, R.N. Brookhaven National Lab., Upton, NY (USA). Jan 1990. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-900171–1: 1. international symposium on microbiology of the deep subsurface, Orlando, FL (USA), 15-18 Jan 1990). Order Number DE90006766. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Perfluorocarbon tracers, PFTs, a multitracer technology of seven chemical tracers, were used to tag the drilling muds used in the Fourth Investigators Hole of the Deep Probe experiments. PFTs are fully fluorinated alkyl substituted cycloalkanes, which are inert, non-toxic and chemically non-reactive, detectable in these applications to 1 picoliter/gram of sample by gas chromatographic electron capture detection. PFTs were incorporated into the drilling muds at the 100,000 p1/gm level by addition of a 1% PFT microemulsion in H_2O during the periodic preparation of drilling muds. A total of four different PFTs were used to tag the drilling mud used in the stratigraphic core and sample wells; two PFTs were used in the core well and two further PFTs in the sample well. After sampling, a small aliquot of samples was forwarded to the Tracer Technology Center (TTC) for PFT analysis along with samples of the tagged muds. The samples were centrifuged and headspace sampled for PFT. Results of the PFT analyses were then used to assess the degree of drilling mud contamination of the retrieved samples. The results indicated some contamination of the retrieved samples and some transport of fluids from the core well to the sampling well, which are quantitated by the measured PFT concentrations. 8 refs., 3 tabs.

20350 (BNL–43551) **Laboratory studies of free radical reactions in cloudwater.** Schwartz, S.E.; Weinstein-Lloyd, J. Brookhaven National Lab., Upton, NY (USA). Nov 1989. 7p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract AC02-76CH00016. ATM-8808480. (CONF-900402–2: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990). Order Number DE90003961. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Reactions in cloudwater can be important pathways for chemical transformation of atmospheric trace gases because of high solubility of reagent gases, rapid aqueous-phase kinetics, and large thermodynamic driving force. A key cloudwater reaction is oxidized of dissolved SO_2 and H_2O_2. It is thus important to understand processes controlling H_2O_2 formation in the atmosphere by gas- and aqueous-phase reactions of HO_2 free radicals. A concern with models of free radical chemistry in cloudwater is that of the applicability of present chemical kinetic schemes to such complex milieus. This concern arises because, at the low free-radical concentrations expected for cloudwater, reactions of radicals with trace impurities are favored over radical-radical reactions, which dominate at high radical concentrations commonly employed in laboratory investigations. We report initial results of a study in which the rate of change in H_2O_2 concentration is monitored in synthetic and authentic cloudwater in which HO_2 radicals are produced by $^{60}Co\gamma$ radiolysis at rates comparable to those expected upon transfer of HO_2 from interstitial cloud air to cloudwater. These results indicate that micromolar concentrations of Fe(III) decrease H_2O_2 yields and can even lead to H_2O_2 loss rather than formation. Implications on cloud chemistry will be discussed. 14 refs., 2 figs.

20351 (BNL–43812) **Adaptation of the perfluorocarbon tracer technology for aqueous-phase studies in subsurface applications.** Senum, G.I.; Goodrich, R.W.; Wilson, R.; Dietz, R.N. Brookhaven National Lab., Upton, NY (USA). Jan 1990. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. Order Number DE90007356. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The perfluorocarbon tracer (PFT) technology as developed by the Tracer Technology Center at Brookhaven National Laboratory can be easily adapted for use as in aqueous-phase tracer studies in subsurface hydrological applications. The advantages of the PFT technology in this application is that it is a multi-tracer technology, up to 5 or 6 PFTs may be used in an experiment, the PFTs are completely non-toxic and inert, the PFTs can be detected to 4 orders greater sensitivity than fluorescent dyes. The disadvantages are that the PFTs are only sparingly soluble in water and are also

volatile. They are minimized by the PFT deployment and sampling methodologies which are given in this report. 15 refs., 3 tabs.

20352 (CONF-8908155–2) **Simulation of the scale-dependent effects of landscape boundaries on species persistence and dispersal.** Gardner, R.H. (Oak Ridge National Lab., TN (USA)); Turner, M.G.; O'Neill, R.V.; Lavorel, S. Oak Ridge National Lab., TN (USA). [1989]. 31p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC05-84OR21400. From 1989 Ecological Society of America symposium on the role of landscape boundaries in the management and restoration of changing environments; Toronto (Canada); 7-10 Aug 1989. Order Number DE90006622. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The relationships between life history characteristics and broad-scale patterns of species abundance were investigated with a model that simulates the dispersal of populations through heterogeneous landscapes. Movement was simulated on randomly generated landscapes and on forested landscapes digitized from aerial photographs. Simulation results indicated that population abundances will change suddenly near the critical threshold in habitat connectivity as predicted from percolation theory. The existence of critical thresholds is important for many management and conservation issues, but these thresholds suggest that data are required at spatial scales that are specific to the dispersal characteristics of the simulated population. 37 refs., 9 figs.

20353 (DOE-RW–89.061) **The distribution and dynamics of radionuclides in the terrestrial environment.** Horrill, A.D. (Merlewood Research Station, Grange-over-Sands (UK). Inst. of Terrestrial Ecology); Howson, G.; Mudge, S. Department of the Environment, London (UK). Oct 1988. 125p. Contract PECD-7/9/185-188/83. Order Number DE90617490. Available from NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS.

Caesium-137, plutonium-238 and plutonium-239/240 have been determined in soils and vegetation from West Cumbria. Determinations have been made with reference to the land use which is dominated by grassland management. It can be shown statistically that with respect to caesium-137 land use can affect all soil and vegetation inventory. Indications are that a similar situation holds for the plutonium isotopes. A small data bank of information has been gathered on the land management and farming practices of the study area. (author).

20354 (EPRI-GS–6700) **Remediation technologies for organics contamination: Final report.** Spear, C.E. (Mill Creek Co., Houston, TX (USA)). Electric Power Research Inst., Palo Alto, CA (USA); Mill Creek Co., Houston, TX (USA). c Feb 1990. 107p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Gas was formerly manufactured from coal, coke, and/or oil at thousands of sites; most of these locations are still contaminated by organic and inorganic wastes. This report summarizes what remedial technologies are available, worldwide, to clean them up. The objective is to provide a technical review of current manufactured-gas plant site mitigation technologies in Europe and the United States. 20 refs., 28 figs.

20355 (EPS–89-04698, pp. 87-100) **Secondary containment liners: An overview.** McCallum, W.G. (Guardian Engineered Systems Ltd., Calgary, AB (Canada)). Environment Canada, Ottawa, ON (Canada). Environmental Protection Service. 1989. (CONF-8906284–: 6. technical seminar on chemical spills, Calgary (Canada), 5-6 Jun 1989; MICROLOG–89-04698). In *Proceedings of the sixth technical seminar on chemical spills.* Available from PC Environment Canada, Departmental Library, Ottawa, PQ, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Potential environmental damage and cost of remedial measures, as related to the possible spillage of materials from storage sites, has dictated the necessity for extra facility protection and secondary containment. One of the available options is the secondary containment geomembrane liner system. Material selection and engineering considerations are discussed, focusing on the most important physical properties of the membrane (permeability, degradation and volume swell) when in contact with the contaminating medium. A method for calculating penetration rates and volumes is included, and other criteria for selection of liner materials are presented. Site design and preparation, and liner installation procedures, are described for surface and subsurface facilities. Recommended specifications for liner installations are provided, which should result in a completely sealed system. Typical designs are shown for a refinery tank farm, bulk station tanks, and service station (underground) tanks. 8 figs., 2 tabs.

20356 (ES/ESH–8/V3) **Paducah Gaseous Diffusion Plant site environmental report for 1988.** Rogers, J.G.; Jett, T.G. Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Paducah Gaseous Diffusion Plant, KY (USA). May 1989. 189p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC05-84OR21400. Order Number DE90005821. Available from NTIS, PC A09/MF A01; OSTI; INIS; GPO Dep.

Quantities of nonradiological chemical emissions are not included in this report this year. An addendum that will include the information will be published after the Superfund Amendments Reauthorization Act (SARA) Title III report is issued on July 1, 1989. When the addendum is published, probably in late July, a summary of the SARA Title III 313 report will be included. The SARA report provides the community with the opportunity to lean about estimated quantities of certain toxic chemicals used at a facility that are routinely or accidentally released into the environment. The addendum that will be published after the SARA report will summarize the SARA report and is expected to include some additional "large quantity" chemicals used or stored at the facilities that are not required to be reported by SARA Title III but are known to be emitted from the facilities. The addendum will not be all inclusive but will provide emissions information on the major chemical emissions to the air, water, or land from processes at the facilities.

20357 (HAZ–CE02857, pp. 201-214) **A new method for the detection and measurement of aromatic compounds in water.** Hanby, J.D. (Hanby Analytical Labs., Inc., Houston, TX (USA)). Haztech Canada, Edmonton, AB (Canada). 1989. (CONF-8905280–: Haztech Canada Toronto '89: environmental control/hazardous waste management conference, Mississauga (Canada), 16-18 May 1989; CE–02857). In *Haztech Canada Toronto '89: Environmental control/hazardous waste management conference proceedings.* Available from Haztech Canada, 4936-87th St., no. 26, Edmonton, AB, CAN T6E 5W3. Prices: $50.00 CAN.

A Field Test Kit procedure for the rapid analysis of petroleum aromatic hydrocarbons over a wide range of concentrations in water and soil has proven useful for the assessments at spill sites, hazardous waste areas and underground storage tank removal locations. The kit was used to evaluate diesel oil concentrations at the Ashland Oil spill on the Monongahela River and in conjunction with Environmental Protection Agency's studies of the oil concentrations in the Ohio River at Wheeling, West Virginia. A study of gasoline-in-soil at concentrations ranging from 5 mg/kg to 10,000 mg/kg was conducted. The colorimetric results from the procedure in both water and soil are determined by comparison to a color chart. Ultraviolet/visible spectrophotometric studies were performed to determine the relationship of concentration to color intensity (reflectance). Studies were also performed on the use of the reaction to detect the presence of alkene halides in water samples. The precision of Purge and Trap Gas Chromatography analysis was compared to the results given by the Field Test Kit; the precision by the kit was found to be higher. Field Test Kits are currently being used in the analysis of the aromatics in the water of Prince William Sound resulting from the oil spill at Valdez. Preliminary data from these tests are discussed. 7 refs., 3 figs., 1 tab.

20358 (INFO–0248) **Use of biological indicators to evaluate environmental stress.** Letourneau, C.; Castonguay, J. Atomic Energy Control Board, Ottawa, ON (Canada). Sep 1987. 69p. (In French). Order Number DE90617555. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

This report examines the usefulness of biological analyses for evaluating environmental stress. All forms of stress are addressed; particular attention, however, is paid to the use of biological analyses to evaluate the impact on the environment from radioactive

releases of the nuclear industry. First, we will review different biological analyses which are grouped into two approaches: the holistic approach (biotic and diversity indices) and the reductionist approach ('biological indicators' per se). Secondly, we will compare the usefulness of plants and animals as indicators based on the established criteria. This report ends with a compilation of letters received from different organizations which outline the present usage in Canada of biological indicators for evaluating environmental stress.

20359 (INP–1348/B) **Ground deposition of long-lived gamma emitters in Poland from the Chernobyl accident.** Krolas, K. (Uniwersytet Jagiellonski, Cracow (Poland). Inst. Fizyki); Kubala, M.; Sciezor, T. Institute of Nuclear Physics, Cracow (Poland). Dec 1986. 14p. Order Number DE90617649. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Activity composition was measured for the soil contaminated with the fallout from the Chernobyl accident. Soil samples were collected at various areas of Poland. A map showing the ^{137}Cs deposit distribution was drawn for the most contaminated southern part of Poland. 9 refs., 5 figs. (author).

20360 (IPEN-PUB–271) **Determination of the cesium distribution coefficient in Goiania and Abadia de Goias cities soils.** Marumo, J.T.; Suarez, A.A. Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo, SP (Brazil). Oct 1989. 21p. Order Number DE90617492. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In September, 1987, an unauthorized removal of a cesium-therapy unit and its violation caused an accident, where several places of Goiania's city, capital of Goias, Brazil, were contaminated. The removal of the radioactive wastes generated from decontamination process, was made to Abadia de Goias city (near Goiania), where an interim storage was constructed. Soil samples collected from the 57th Street (Goiania) and from the interim storage permitted to determine, through static method, the cesium distribution coefficent for different cesium solution concentrations. Those results allows for some migration/retention evaluations in disposal site selection. Some soils parameters (water content, density, granulometric analysis etc) as well as clay minerals constituents were also determined. (author).

20361 (IVL-B–931) **Chloro-organic substances in the environment: Summary of lectures at the Swedish Environmental Research Institute Conference 1989.** Institutet foer Vatten- och Luftvaardsforskning, Stockholm (Sweden). Jan 1989. 75p. (In Swedish). (CONF-8901179–Summ.: Chloro-organic substances in the environment, Stockholm (Sweden), 25 Jan 1989). Order Number DE90748555. Available from NTIS (US Sales Only), PC A04/MF A01.

Lectures were given on the following topics: * Chloroorganics - chemical properties, use, formation and emission sources. * Chlorine in a global perspective. * Large-scale dissemination by air. * Large-scale dissemination by water. * Presence in flora and fauna. * Presence in occupational environment. * Influence of CFCs on ozone layer. * Health effects of dioxins and other chloroorganics. * Breaking down and transformation of chlorinated substances. * Process integrated measures for emission reduction of chloroorganics from the forest industry. * Purification technology for bleachery waste water in the forest industry. * Process integrated measures and recovery (other industries). * Gas purification - Elimination of chloroorganics from gas flows. * Waste water purification. * Measures in connection with refuse incineration and other combustion. * Chloroorganics in pesticides, herbicides and consumer products. * Handling of chlorine containing wastes.

20362 (LA–11628-ENV) **Environmental surveillance at Los Alamos during 1988.** Los Alamos National Lab., NM (USA). Jun 1989. 245p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. Order Number DE90006405. Available from NTIS, PC A11/MF A01 - OSTI; GPO Dep.

This report describes the environmental surveillance program conducted by Los Alamos National Laboratory during 1988. Routine monitoring for radiation and radioactive or chemical materials is conducted on the Laboratory site as well as in the surrounding region. Monitoring results are used to determine compliance appropriate standards and to permit early identification of potentially undesirable trends. Results and interpretation of data for 1988 cover: external penetrating radiation; quantities of airborne emissions and liquid effluents; concentrations of chemicals and radionuclides in ambient air, surface and ground waters, municipal water supply, soils and sediments, and foodstuffs; and environmental compliance. Comparisons with appropriate standards, regulations, and background levels provide the basis for concluding that environmental effects from Laboratory operations are insignificant and do not pose a threat to the public, Laboratory employees, or the environment. 41 refs., 30 figs., 121 tabs.

20363 (N–90-12090) **Global data bases on distribution, characteristics and methane emission of natural wetlands: Documentation of archived data tape.** Matthews, E. National Aeronautics and Space Administration, New York, NY (USA). Goddard Inst. for Space Studies. Nov 1989. 22p. (NASA-TM–4153;REPT–90-005;NAS–1.15:4153). Available from NTIS, PC A03/MF A01.

Global digital data bases on the distribution and environmental characteristics of natural wetlands, compiled by Matthews and Fung (1987), were archived for public use. These data bases were developed to evaluate the role of wetlands in the annual emission of methane from terrestrial sources. Five global 1 deg latitude by 1 deg longitude arrays are included on the archived tape. The arrays are: (1) wetland data source, (2) wetland type, (3) fractional inundation, (4) vegetation type, and (5) soil type. The first three data bases on wetland locations were published by Matthews and Fung (1987). The last two arrays contain ancillary information about these wetland locations: vegetation type is from the data of Matthews (1983) and soil type from the data of Zobler (1986). Users should consult original publications for complete discussion of the data bases. This short paper is designed only to document the tape, and briefly explain the data sets and their initial application to estimating the annual emission of methane from natural wetlands. Included is information about array characteristics such as dimensions, read formats, record lengths, blocksizes and value ranges, and descriptions and translation tables for the individual data bases.

20364 (OEFZS-A–1499) **Regional prognosis for large-area radioactive contamination, based on the ECOSYS model. Final report.** Gerzabek, M. (and others); Horak, O.; Humer, H. Oesterreichisches Forschungszentrum Seibersdorf G.m.b.H. (Austria). Aug 1989. 254p. (In German). (LA–218/89;ST–170/89;PH–474/89;MI–102/89;NU–103/89). Available from the Austrian Research Centre Seibersdorf, A-2444 Seibersdorf (Austria). Available from the Austrian Research Centre Seibersdorf, A-2444 Seibersdorf (Austria).

A revised version of this Final Report has been issued as OEFZS-A–1526 report, October 1989; Limited distribution.

The radioecological model ECOSYS-87 (developed by GSF, Neuherberg/Munich) has been adapted for Austria. The resulting model version OECOSYS allows regionally differentiated prognoses of the consequences of nuclear fallout (food contamination and population doses). By combining geographical informations about agricultural regions, depositions, food production and food consumption detailled prognoses may be calculated for regions on the level of Austrian county districts (99 districts in 83.000 km^2). The practicability of the model was tested applying data from Chernobyl fallout. The model is very sensitive in respect to the development of crop plants and the precise calculation of depositions on plant surfaces. 26 refs., 52 figs., 52 tabs. (Authors).

20365 (OEFZS-A–1526) **Regional prognosis for large-area radioactive contamination, based on the ECOSYS model. Final report, revised.** Gerzabek, M. (and others); Horak, O.; Humer, H. Oesterreichisches Forschungszentrum Seibersdorf G.m.b.H. (Austria). Oct 1989. 257p. (In German). (LA–221/89;ST–172/89;PH–478/89;MI–103/89;NU–112/89). Available from the Austrian Research Centre Seibersdorf, A-2444 Seibersdorf (Austria). Available from the Austrian Research Centre Seibersdorf, A-2444 Seibersdorf (Austria).

This is a revised version of the Final Report issued as OEFZS-A–1499 report, August 1989; Limited distribution.

The radioecological model ECOSYS-87 developed by GSF Muenchen has been adapted for Austria. The resulting model version OECOSYS allows a regionally differentiated forecast of the consequences of nuclear fallout on food contamination and population doses. By combining information about diverse agricultural regions, depositions, food production and food consumption, a detailed prognosis may be obtained for regions on the level of Austrian county districts (99 districts in 83.000 km^2), thus allowing quicker and more specific measures to keep population doses as low as possible in future. The practicability of the model was tested by applying numerous measurement data after the Chernobyl fallout. A good agreement was found between the forecast and the measured activity concentrations in food stuff. The problems in the validation due to the sensitivity of the model to the stage of development of crop plants and to the accurate modelling of the deposition on plant surfaces as well as the question of representative samples for comparison are discussed extensively. The Austrian average of the theoretical ingestion dose in the first year after the accident was 0,8 mSv effective dose equivalent for adults. This value was obtained regardless of the effects of countermeasures by the authorities. The regional ingestion does show little differences. The dose reduction due to countermeasures was estimated at appr. 0,3 mSv, thus reducing the average ingestion dose to 0,5 mSv. 26 refs., 51 tabs., 52 figs. (Authors).

20366 (ORNL–6526/R11) **Environmental Regulatory Update Table, December 1989.** Houlbert, L.M. (Tennessee Univ., Knoxville, TN (USA)); Langston, M.E.; Nikbakht, A.; Salk, M.S. Oak Ridge National Lab., TN (USA). Jan 1990. 113p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC05-84OR21400. Order Number DE90006433. Available from NTIS, PC A06/MF A01; OSTI; INIS; GPO Dep.

The Environmental Regulatory Update Table provides information on regulatory initiatives of interest to DOE operations and contractor staff with environmental management responsibilities. The table is updated each month with information from the Federal Register and other sources, including direct contact with regulatory agencies. Each table entry provides a chronological record of the rulemaking process for that initiative with an abstract and a projection of further action.

20367 (PB–90-126665/XAB) **Terra Vac in-situ vacuum extraction system: Applications analysis report.** Stinson, M. Foster Wheeler Enviresponse, Inc., Edison, NJ (USA). Jul 1989. 65p. Available from NTIS, PC A04/MF A01.

Color illustrations reproduced in black and white.

This document is an evaluation of the Terra Vac in-situ-vacuum extraction system and its applicability as a treatment method for waste-site cleanup. The report analyzes the results from the Superfund Innovative Technology Evaluation (SITE) Program's 56-day demonstration at the Valley Manufactured Product Company's site in Groveland, Massachusetts and data from other applications. Conclusions were reached concerning the technology's suitability for use in remediations involving both similar and different materials at other sites. Operational data and sampling and analysis information were monitored carefully to establish a data base against which vendor's claims for the technology could be evaluated. The conclusions from the results of the Groveland demonstration test and from other available data are: (1) the process can be used to remediate a site contaminated with VOCs; (2) the process can remove VOCs from soils with permeabilities as low as 10^{-8} cm/s; (3) the process operates well in all weather conditions; and (4) the process implementation costs can be as low as $10/ton, depending on various site-specific conditions.

20368 (PNL–7241) **Data compilation task report for the source investigation of the 300-FF-1 operable unit phase 1 remedial investigation.** Young, J.S.; Fruland, R.M.; Fruchter, J.S. Pacific Northwest Lab., Richland, WA (USA). Feb 1990. 47p. Sponsored by U.S. DOE Energy Research. DOE Contract AC06-76RL01830. Order Number DE90006979. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This report provides additional information on facility and waste characteristics for the 300-FF-1 operable unit. The additional information gathered and reported includes meetings and on-site visits with current and past personnel having knowledge of operations in the operable unit, a more precise determination of the location of the Process Sewer lines and Retired Radioactive Liquid Waste Sewer, a better understanding of the phosphoric acid spill at the 340 Complex, and a search for engineering plans and environmental reports related to the operable unit. As a result of this data-gathering effort, recommendations for further investigation include characterization of the 307 Trenches to determine the origin of an underlying uranium plume in the groundwater, more extensive sampling of near-surface and dike sediments in the North and South Process Ponds to better define the extent of horizontal contamination, and detection of possible leaks in the abandoned Radioactive Waste Sewer by either electromagnetic induction or remote television camera inspection techniques. 16 refs., 4 figs., 5 tabs.

20369 (PSI–35) **Hydrologic modelling of the migration site in the Grimsel rock laboratory -the steady state.** Herzog, F. (Paul Scherrer Inst. (PSI), Wuerenlingen (Switzerland). Programm Entsorgung). Paul Scherrer Inst. (PSI), Wuerenlingen (Switzerland). Jul 1989. 37p. Order Number DE90615971. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Tracer migration experiments are in progress at the Grimsel Test Site (GTS) in order to test radionuclide transport models and to develop appropriate experimental techniques. In order to assist design and to interpret field tracer tests the knowledge of the hydrology of the site is essential. This report describes the hydraulic modelling efforts with the following objectives: (1) to interpret experimental findings. (2) to provide input, such as flowpaths and flow velocities, for transport modelling. (3) to assist in the design of the tracer experiments. The model concept is based upon the observations, that the fracture, where the migration experiments will take place, is relatively planar, has an average aperture of a few millimeters and is filled with a clayish mateial: The migration fracture is modelled as a two-dimensional, isotropic, heterogeneous equivalent porous medium. To allow for a sufficiently detailed model a hierarchical approach was followed where the boundaries for the 'local' model, i.e. the model in the vicinity of the migration site, were taken by first solving a larger 'regional' model with coarser discretization. Transmissivity values as extracted from single borehole tests were used for definition of the heterogeneous transmissivity field in the model calculations. Model results for hydrostatic pressures and discharge rates compare favourably with experimental data, even though some problems remain to be resolved. Calculations for dipole arrangements have been performed; they turned out to be useful tools for deciding on injection- and withdrawal rates to be applied in the migration experiments as well as for qualitatively estimating tracer recovery rates. (author) 20 figs., 10 tabs., 11 refs.

20370 (SAND–89-1988C) **One-dimensional radionuclide transport under time-varying conditions.** Gelbard, F. (Sandia National Labs., Albuquerque, NM (USA)); Olague, N.E.; Longsine, D.E. Sandia National Labs., Albuquerque, NM (USA). [1989]. 9p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC04-76DP00789. (CONF-900406–9: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90005402. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

New analytical and numerical solutions are presented for one- dimensional radionuclide transport under time-varying fluid-flow conditions including radioactive decay. The analytical solution assumes that all radionuclides have identical retardation factors, and is limited to instantaneous releases. The numerical solution does not have these limitations, but is tested against the limiting case given for the analytical solution. Reasonable agreement between the two solutions was found. Examples are given for the transport of a three-member radionuclide chain transported over distances and flow rates comparable to those reported for Yucca Mountain, the proposed disposal site for high-level nuclear waste. 13 refs., 2 figs.

20371 (SREL–37) **Wood storks of the Birdsville colony and swamps of the Savannah River Plant: 1988 annual report.** Coulter, M.C. Savannah River Ecology Lab., Aiken, SC (USA). Div. of Stress and Wildlife Ecology. Aug 1989. 310p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-76SR00819.

Order Number DE90006980. Available from NTIS, PC A14/MF A01 - OSTI; GPO Dep.

The Savannah River Ecology Laboratory (SREL) Wood Stork program is a long-term program including various facets. It is primarily aimed at determining the importance of the SRSS to foraging storks and managing the Kathwood Foraging Ponds. In order to accomplish this, we have examined the breeding biology of the birds at the colony to determine when the birds may have maximum food demand. We have also studied foraging ecology of the birds in order to gain insights that would allow us to develop a more effective management plan for the Kathwood ponds. More specifically, the objectives of the work carried out in 1988 were: (1) to determine the locations of foraging sites of Wood Storks from the Birdsville colony and examine year-to-year variation in sites used; (2) to characterize in more detail the habitat, vegetation, water quality and prey density/biomass at these sites; (3) to observe the breeding birds to determine times when food demands at the colony are greatest; (4) to examine the movements of storks from the rookery to foraging sites and related seasonal trends to the breeding biology; (5) to examine the importance of the SRSS to foraging Wood Storks; and (6) to examine the movements of individual birds to determine the generality of the observed patterns. At the Kathwood ponds we monitored water quality to ensure that water conditions were optimal for the stocked aquatic ponds, determined when to make the ponds available to the storks, and monitored the numbers of storks and other wading birds at the ponds. In this report, I present the results of these studies conducted in 1988. 30 refs., 107 figs., 81 tabs.

20372 (VTT-SYMP–103, pp. 151-170) **Induced soil venting of hydrocarbon contaminated soil.** Hoad, G.A. (University of Connecticut, Storrs. Connecticut (USA). Department of Civil Engineering); Marley, M.C.; Baehr, A.L. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). 1989. (CONF-8806445–Vol.2: Seminar on non-waste technology, Espoo (Finland), 20-23 Jun 1988). In *Non-waste technology: Volume 2.* Order Number DE90748455. Available from NTIS (US Sales Only), PC A16/MF A01.

Induced soil venting is a process for removing immiscible contaminants, such as gasoline, from the unsaturated zone. Air is withdrawn from the unsaturated zone which results in hydrocarbon vapor movement along the induced flow path toward a collection pipe. Factors affecting process performance are vapor pressures of the contaminants, air permeability of the soil and the ability to develop a flow field which encompasses the immiscible contaminants. A synthesis of a laboratory experiments, modeling and full-scale implementation of the soil venting process to remove gasoline from the subsurface are discussed. Results of laboratory studies using soil columns at field capacity moisture content, reveal that 100 l percent of the gasoline at residual saturation can be removed by soil venting. A detailed analysis is made of the mechanisms affecting system performance, considering physical and chemical factors based on laboratory and field data. Application of the process to remediate soil contaminated with other volatile contaminants is also discussed.

20373 Developing role of chemists in the field of solid and hazardous waste management. Pojasek, R.B. (Chem-Cycle Corp., Boston, MA (USA)); Jolley, R.L. *Preprints of Papers Presented at National Meeting, Division of Water, Air and Waste Chemistry, American Chemical Society (USA),* 28(2): 49-50 (Sep 1988). (CONF-8909231–: Computer software and applications conference, Orlando, FL (USA), 20-22 Sep 1989).

Many efforts have been initiated to involve chemists and chemical engineers in the solution of some very difficult problems. Many members of the Environmental Chemistry Division of the American Chemical Society have been involved in these efforts. This paper will examine many of the ways chemistry has been increasingly used in hazardous waste management programs.

20374 Competition and abiotic stress among trees and shrubs in northwest Colorado. Welden, C.W. (Colorado State Univ., Fort Collins (USA)); Slauson, W.L.; Ward, R.T. *Ecology (USA),* 69(5): 1566-1577 (Oct 1988).

We tested several hypotheses about the relationship of competition to abiotic stress, using the vegetation of the semiarid Piceance Basin of northwestern Colorado. We studied competition among the shrubs Amelanchier utahensis, Artemisia tridentata, and Symphoricarpos oreophilus, and between the trees Pinus edulis and Juniperus osteosperma, in 10 sites. We calculated several indices of abiotic moisture stress, based on the slope, aspect, and elevation of each site. Competition was measured by regressions of the distance separating neighboring plants vs. the sum of their canopy areas. We detected competition among these plants in all but one combination of species and in most sites. No significant differences in the intensity of competition were found within species combinations. Significant differences in the importance of competition were found in one of three interspecific combinations of shrub species, and in two of three combinations of tree species. Neither the intensity nor the importance of competition showed any consistent relationship with any index of abiotic moisture stress. Thus, no hypothesized relationship between abiotic stress and competition is supported. Our data also show no consistent relationship between the importance of competition and its intensity, supporting our hypothesis that the intensity and the importance of competition are independent.

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Refer also to citation(s) 19205, 19206, 19283, 19285, 19287, 19288, 19289, 19290, 19291, 19292, 19293, 19294, 19419, 19420, 19424, 19427, 19428, 19429, 19430, 19431, 19432, 19433, 19434, 19435, 19438, 19480, 19691, 19702, 19811, 19978, 19979, 19981, 20266, 20267, 20275, 20292, 20310, 20311, 20312, 20313, 20314, 20315, 20316, 20317, 20318, 20319, 20320, 20321, 20322, 20334, 20346, 20356, 20357, 20361, 20362, 20456, 20470, 20471, 20472, 20474, 20477, 20481, 20483, 20788

20375 (AECL–9711) **Long-term predictions of water table from precipitation analysis for a waste disposal site.** Devgun, J.S.; Wilkinson, S.R. Atomic Energy of Canada Ltd., Chalk River, ON (Canada). Chalk River Nuclear Labs. Mar 1988. 14p. (CONF-880201–: Waste management '88: symposium on radioactive waste management, Tucson, AZ (USA), 28 Feb - 3 mar 1988). Order Number DE90617654. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Long-term predictions of water table fluctuations at a waste disposal site have been made from precipitation analysis. Two methods have been applied: a statistical/empirical correlative approach, and a hydrogeologic modelling approach using the finite difference code SWIFT (Simulator for Waste Injection Flow and Transport). This paper discusses the methodology and the results of these assessments.

20376 (Beitraege–1/89, pp. 55-127) **Valuating report on measurements of radionuclide concentrations in surface waters 1987.** Henrich, E. (Bundesanstalt fuer Lebensmitteluntersuchung und Lebensmittelforschung, Vienna (Austria). Abt. Strahlenschutz); Friedrich, M.; Zapletal, M.; Haider, W. Bundesministerium fuer Gesundheit und Umweltschutz, Vienna (Austria). 1989. (In German). In *Radioactivity monitoring network: Measurements 1987.* Order Number DE90617487. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

Methods of sample collection, sample preparation and data processing are outlined. A lot of data are presented in tables, figures and maps. The valuation consists of hypotheses about the origin of the particular nuclides. 28 tabs., 33 figs., 11 refs. (qui).

20377 (Beitraege–1/89, pp. 128-186) **Valuating report on measurements of radionuclide concentrations in the waste water and mixed slurry of the Vienna Main Clarification Plant 1987.** Henrich, E. (Bundesanstalt fuer Lebensmitteluntersuchung und Lebensmittelforschung, Vienna (Austria). Abt. Strahlenschutz); Friedrich, M.; Zapletal, M.; Weisz, J.; Haider, W. Bundesministerium fuer Gesundheit und Umweltschutz, Vienna (Austria). 1989. (In German). In *Radioactivity monitoring network: Measurements 1987.* Order Number DE90617487. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

Methods of sample collection, sample preparation and data processing are outlined. A lot of data are presented in tables, figures

and maps. The evaluation consists of hypotheses about the origin of the particular nuclides. 31 tabs., 9 figs., 13 refs. (qui).

20378 (Beitraege–1/89, pp. 187-212) **Tritium in surface waters 1987.** Schoenhofer, F. (Bundesanstalt fuer Lebensmitteluntersuchung und Lebensmittelforschung, Vienna (Austria). Abt. Strahlenschutz); Weisz, J. Bundesministerium fuer Gesundheit und Umweltschutz, Vienna (Austria). 1989. (In German). In *Radioactivity monitoring network: Measurements 1987.* Order Number DE90617487. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

The concentration of tritium in surface water from sampling stations at the rivers and lakes Danube, March, Thaya, Mur, Drau, Ill, Inn, Leitha, Rhein, Salzach, Neusiedler See, Fuschlsee are given. The measurements were done by liquid scintillation counting without enrichment with an ultra-low-level-counter. As expected no rise due to the accident in Chernobyl could be found. Only in the river Thaya at Bernhardsthal slightly elevated levels were found which might originate from the nuclear power plant at Dukovany in CSSR. 9 figs., 12 tabs., 44 refs. (qui).

20379 (BR–85(7.24)) **The ecology of stream and riparian habitats of the Great Basin region: A community profile.** Minshall, G.W. (Idaho State Univ., Pocatello, ID (USA). Dept. of Biological Sciences); Jensen, S.E.; Platts, W.S. National Wetlands Research Center, Slidell, LA (USA); Idaho State Univ., Pocatello, ID (USA). Dept. of Biological Sciences; White Horse Associates, Smithfield, UT (USA); Forest Service, Boise, ID (USA). Intermountain Forest and Range Experiment Station. Sep 1989. 142p. Sponsored by U.S. Department of the Interior. Available from NTIS, PC A; OSTI; US Fish and Wildlife Service, 18th and C Streets, NW, MS 1111, Arlington Square Bldg., Washington, DC 20240.

Surface waters of the Great Basin include perennial, intermittent, and ephemeral streams; freshwater and saline lakes; playa lakes; freshwater and saline wetlands and thermal springs associated with faulting and volcanic activity. All of these aquatic habitats generally have associated riparian habitats. However, riparian habitats of the Great Basin may be more mesic than the riparian habitats of the eastern United States. The Great Basin comprises the northern half of the Basin and Range Physiographic Province and covers most of Nevada and western Utah and portions of California, Oregon, and Idaho. The entire basin actually consists of numerous subbasins and mountain ranges which present an extremely diverse physical setting. Typical mountains range from about 2100–3000 m in elevation while subbasin floors are typically 1500–1800 m in elevation. The entire Great Basin lies in the rain shadow of the Sierra Nevada Mountains and the regions is semi-arid to arid. Riparian and stream habitats within the Great Basin have received less attention from ecologists than similar habitats elsewhere in the United States. As a consequence, little is known about biotic communities or about certain aspects of structure and functioning of these ecosystems.

20380 (DOE-RW–88.085) **Pocos de Caldas Project: Feasibility study (final report June 1986 - May 1987).** British Geological Survey, Keyworth (UK); Department of the Environment, London (UK). 1988. 24p. Order Number DE90617506. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The first annual report of the Pocos de Caldas Project describes the results of the feasibility study established to test the objectives of the work. Boreholes have been drilled at two sites, the Osamu Utsumi uranium mine and Morro do Ferro, to assess the feasibility of using them as natural analogues of radionuclide migration processes. Detailed geochemical analysis and hydrogeological studies are described. (author).

20381 (DOE-RW–89.019) **Pocos de Caldas Project: Second year final report (June 1987 - May 1988).** British Geological Survey, Keyworth (UK); Department of the Environment, London (UK). 1989. 99p. Order Number DE90617507. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

The second annual report of the Pocos de Caldas Project describes the results of the first phase of the post-feasibility study investigations. Boreholes have been drilled at two sites, the Osamu Utsumi uranium mine and Morro do Ferro, and rock and groundwater samples analysed to provide data on natural analogues of radionuclide migration processes. These detailed geochemical analysis and hydrogeological studies are described, and related to four specific objectives concerning issues of importance in repository performance assessment. (author).

20382 (INFO–0203-1) **A compilation of subsurface hydrogeologic data: Volume 1 - Main report.** Atomic Energy Control Board, Ottawa, ON (Canada); Geologic Testing Consultants, Ottawa, ON (Canada). Mar 1986. 264p. Order Number DE90617512. Available from NTIS (US Sales Only), PC A12/MF A01; OSTI; INIS.

This report presents a compilation of both fracture properties and hydrogeological parameters relevant to the flow of groundwater in fractured rock systems. Methods of data acquisition as well as the scale of and conditions during the measurement are recorded. Measurements and analytical techniques for each of the parameters under consideration have been reviewed with respect to their methodology, assumptions and accuracy. Both the rock type and geologic setting associated with these measurements have also been recorded. 373 refs.

20383 (INFO–0203-2) **A compilation of subsurface hydrogeologic data: Volume 2 - Appendix A.** Atomic Energy Control Board, Ottawa, ON (Canada); Geologic Testing Consultants, Ottawa, ON (Canada). Mar 1986. 368p. Order Number DE90617513. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

This volume contains the permeability data for the research sites discussed in Volume 1 which have been studied in sufficient detail to allow for analysis. These sites are the following: Stripa Mine, Sweden; Finnsjon, Kamlunge, Fjallveden, Gidea, Svartboberget, Sweden; Olkiluoto, Loviisa, Lavia, Finland; Climax Granite Nevada Test Site; OCRD Room, Colorado School of Mines; Savannah River Plant, Aiken, South Carolina; Oracle, Arizona; Basalt Waste Isolation Project (BWIP), Hanford, Washington; Underground Research Laboratory, AECL, Canada; Atikokan Research Area, AECL; Chalk River Research Area, AECL; Whiteshell Research Area, AECL. Other sources of information have been included where sufficient site specific geologic and hydrogeologic information is provided.

20384 (INFO–0203-3) **A compilation of subsurface hydrogeologic data: Volume 3 - Appendices B and C.** Atomic Energy Control Board, Ottawa, ON (Canada); Geologic Testing Consultants, Ottawa, ON (Canada). Mar 1986. 333p. Order Number DE90617514. Available from NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

This volume contains the storage coefficient, porosity, compressibility and fracture data for the research sites discussed in Volume 1 which have been studied in sufficient detail to allow for analysis. These sites are the following: Stripa Mine, Sweden; Finnsjon, Kamlunge, Fjallveden, Gidea, Svartboberget, Sweden; Olkiluoto, Loviisa, Lavia, Finland; Climax Granite Nevada Test Site; OCRD Room, Colorado School of Mines; Savannah River Plant, Aiken, South Carolina; Oracle, Arizona; Basalt Waste Isolation Project (BWIP), Hanford, Washington; Underground Research Laboratory, AECL, Canada; Atikokan Research Area, AECL; Chalk River Research Area, AECL; Whiteshell Research Area, AECL. Other sources of information have been included where sufficient site specific geologic and hydrogeologic information is provided. The fracture data for the first three of the sites listed above are contained in this volume. The fracture data for the remaining research research sites are discussed in Volume 4.

20385 (INFO–0203-4) **A compilation of subsurface hydrogeologic data: Volume 4 - Appendix C (continued).** Atomic Energy Control Board, Ottawa, ON (Canada); Geologic Testing Consultants, Ottawa, ON (Canada). Mar 1986. 307p. Order Number DE90617515. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

This volume contains a continuation of the fracture data for the research sites discussed in Volume 1 which have been studied in sufficient detail to allow for analysis. The sites discussed in this volume are the following: Climax Granite Nevada Test Site; OCRD Room, Colorado School of Mines; Savannah River Plant, Aiken, South Carolina; Oracle, Arizona; Basalt Waste Isolation Project (BWIP), Hanford, Washington Underground Research Laboratory, AECL, Canada; Atikokan Research Area, AECL; Chalk River Research Area, AECL; Whiteshell Research Area, AECL. Other

sources of information have been included where sufficient site specific geologic and hydrogeologic information is provided.

20386 (NIPER–450) **Application of natural isotopes in groundwater for solving environmental problems: Final report.** Szpakiewicz, M. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Mar 1990. 70p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC22-83FE60149. Order Number DE90000223. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

An aim of this project is to review a diverse body of information presently scattered throughout the international groundwater literature and demonstrate the usefulness of natural isotopes in environmental research. Identification of isotopic composition of water molecules, dissolved compounds, and undissociated gases in a protected groundwater system provides valuable and sometimes unique information for quantification of critical parameters in groundwater modeling. The most applicable isotopes in the environmental area are such natural isotopes as oxygen-18, deuterium, tritium, radiocarbon, carbon-13, sulfur-34, chlorine-36, and bomb-chlorine-36. A considerable potential is in application of strontium-87, nitrogen-15, chlorine-37, and silicon-32. Some other isotopes may find application for solving specific environmental problems; for example, beryllium-10, krypton-85, argon-39, helium-3, and uranium-234. Yet few such applications have been reported in the United States. This work provides an evaluation of the potential and suggests areas where applications of natural isotope measurements can be most helpful to solving environmental problems. 150 refs., 30 figs., 4 tabs.

20387 (PB–90-125659/XAB) **Uncertainty analysis of runoff estimates from a runoff contour map.** Rochelle, B.P.; Stevens, D.L.; Church, M.R. Environmental Protection Agency, Corvallis, OR (USA). Environmental Research Lab. c 1989. 10p. (EPA–600/J-89/134). Available from NTIS, PC A02/MF A01.

Pub. in Water Resources Bulletin, Vol. 25, No. 3, 491-498(1989).

The US EPA in cooperation with the USGS conducted an analysis to quantify the uncertainty associated with interpolating runoff to specific sites using a runoff contour map. The authors interpolated runoff to 93 gaged watersheds from a runoff contour map using: (1) hand interpolation to the watershed outlet, (2) a computer interpolation to the watershed outlet, and (3) hand interpolation to the watershed centroid. The authors compared the interpolated values to the actual gaged values and found that there was a bias in the average interpolated value for runoff estimated at basin outlets, with interpolated values being less than the actual. The authors found no significant difference between the hand interpolation method and the computer interpolation method except that the computer method tended to have higher variability due to factors inherent to the software used. There were no strong spatial correlations or regional patterns in the runoff interpolations, which indicates that there are no regional biases introduced in the development of the contour map. The authors determined that they could estimate runoff, on the average within approximately 15% of the measured value using the three methods.

20388 (PB–90-125667/XAB) **Classifying soils for acidic deposition aquatic effects: A scheme for the northeast USA.** Lee, J.J.; Lammers, D.A.; Stevens, D.L.; Thornton, K.W.; Wheeler, K.A. Environmental Protection Agency, Corvallis, OR (USA). Environmental Research Lab. c 1989. 13p. (EPA–600/J-89/135). Available from NTIS, PC A03/MF A01.

Pub. in Soil Sci. Soc. Am. Jnl., Vol. 53, 1153-1162(1989).

The Direct/Delayed Response Project (DDRP) is estimating the number of lakes and streams in three U.S. regions that might become acidic due to current or altered levels of acidic deposition, and the long-term time scales involved. Because of the influence of soils on aquatic chemistry, DDRP acquired data on soils that were mapped, sampled, and analyzed consistent methods across the regions. In the northeastern USA, about 600 soils were identified during mapping of 145 watersheds. Because statistically adequate sampling of every soil was impractical the soils were grouped intc 38 sampling classes. Each of these classes was sampled across several watersheds. The properties of soil on specific watersheds (or portions thereof) can be estimated from the regional means and variances of the sampling classes and the percent occurrence of sampling classes on each watershed. This paper describes how the sampling classes for the northeastern USA were developed, the definitions of the classes, and the characteristics of soils within the classes.

20389 (PB–90-125915/XAB) **Acute toxicity of interstitial and particle-bound cadmium to a marine infaunal amphipod.** Kemp, P.F.; Swartz, R.C. Environmental Protection Agency, Newport, OR (USA). Mark O. Hatfield Marine Science Center. c 1988. 22p. (EPA–600/J-88/437). Available from NTIS, PC A03/MF A01.

Pub. in Marine Environmental Research 26, 135-153(1988).

The relative acute toxicity of particle-bound and dissolved interstitial cadmium was investigated using a new bioassay procedure. Interstitial concentration of Cd was controlled by means of peristaltic pumps, allowing separate manipulation of interstitial and particle properties. Addition of small quantities of organic-rich fine particles to sandy sediment resulted in greatly differing particle-bound Cd concentrations in sediment with similar interstitial Cd concentrations. Analysis of variance indicated no significant difference in the survival or ability to rebury in sediment of the phoxocephalid amphipod Rhepoxynius abronius (Barnard), when exposed to sediment with different total Cd concentrations but nearly equal interstitial Cd concentrations; in one case LC50 data indicated slightly increased mortality in sediment with higher total Cd concentration. At least 70.2-87.9% of mortality could be predicted from past data on mortality based on dissolved Cd concentrations. The acute toxicity of Cd to the infaunal amphipod appears to be due principally to Cd dissolved in interstitial water.

20390 (PB–90-128018/XAB) **Anaerobic degradation of chloroaromatic compounds in aquatic sediments under a variety of enrichment conditions.** Genthner, B.R.S.; Price, W.A.; Pritchard, P.H. Technical Resources, Inc., Gulf Breeze, FL (USA). c 1989. 8p. Available from NTIS, PC A02/MF A01.

Pub. in Applied and Environmental Microbiology, Vol. 55, No. 6, 1466-1471(Jun 1989).

Anaerobic degradation of monochlorinated phenols and monochlorinated benzoates by a variety of aquatic sediments was compared under four enrichment conditions. A broader range of compounds was degraded in enrichments inoculated with sediment exposed to industrial effluents. Methanogenic and 1 mM BESA-amended enrichments were most likely, while nitrate and sulfate enrichments least likely, to degrade the compounds tested. Chlorophenols were more readily degraded than chlorobenzoates. However, 2-chlorophenol, 3-chlorophenol, and 3-chlorobenzoate degradation was observed most often and with equal frequency. Para-chlorinated compounds were least likely to be degraded. A relative order of ortho < meta < para was observed for onset of chlorophenol degradation, while the order for chlorobenzoate degradation was meta < ortho < para. In laboratory transfers, 2- and 3-chlorobenzoate degradation was most easily maintained, while degradation of para-chlorinated compounds was least stable.

20391 (PB–90-129149/XAB) **Movement of pesticides and nutrients into tile drainage water. Final report, 22 September 1985-22 September 1988.** Van Scoyoc, G.E.; Kladivko, E.J. Purdue Univ., Lafayette, IN (USA). Dept. of Agronomy. 1989. 95p. Available from NTIS, PC A05/MF A01.

Concern about contamination of surface and ground water by agricultural chemicals has increased in the last five years. The objectives of this study were to determine field-scale pesticide and nutrient losses to tile drains over a 3-year period on a low-organic-matter, poorly structured silt loam soil under typical agricultural management practices. A tile-drainage spacing study was instrumented to measure water outflow rates and to continuously collect tile outflow samples on a flow-proportional basis. Two replicates of 3 tile spacings (5, 10, and 20 m) were included in the study. Water samples were analyzed for all applied pesticides (atrazine, cyanazine, alachlor, carbofuran, terbufos, and chlorpyrifos) as well as major nutrients (N,P,K) and sediment.

20392 (PB–90-129263/XAB) **Overview of selected EPA (Environmental Protection Agency) regulations and guidance affecting POTW (Publicly Owned Treatment Works) management.** Environmental Protection Agency, Washington, DC (USA).

Office of the Assistant Administrator for Water. Sep 1989. 31p. (EPA–430/09-89/008). Available from NTIS, PC A03/MF A01.

The information in the document is meant only as a summary of some of the regulations and guidance that may apply to publicly owned treatment works (POTW) operations. The document does not provide a comprehensive overview of all applicable federal requirements. Use of the document should not replace reference to official regulations as published in the Federal Register or the Code of Federal Regulations or to other more specific guidance documents. Also, the reader should be aware that EPA continuously updates and revises its regulations in response to statutory amendments or to improve its regulatory program. Finally, POTWs are reminded that the Clean Water Act allows states and municipalities to impose more stringent requirements on National Pollutant Discharge Elimination System (NPDES) permittees than are required under federal law. Therefore, EPA suggests that the reader contact the appropriate authorities to get sources of detailed guidance for specific situations.

20393 (PB–90-129313/XAB) **TIME (Temporally Integrated Monitoring of Ecosystems) project: An overview.** Pollack, A.K.; Ford, J. Systems Applications, Inc., San Rafael, CA (USA). c 1989. 18p. Available from NTIS, PC A03/MF A01.

The TIME (Temporally Integrated Monitoring of Ecosystems) project has been in the conceptual and design stage for approximately two years. Delays in implementation have allowed careful attention to many aspects of network design not usually covered prior to field implementation. The network was originally intended as a stand-alone monitoring program, but it has now been incorporated as part of the larger Environmental Monitoring and Assessment Program (EMAP) being planned by Environmental Protection Agency. In this paper, the authors first discuss the stated goals of the TIME project. They then describe the previous EPA projects relating to aquatic effects of acidic deposition upon which the TIME design is based. In the third section the authors describe the conceptual model for the sampling design of the project. The last section describes the purpose and contents of the project Data Analysis Plan, which is under development.

20394 (PB–90-129321/XAB) **Treatment technology for removing radon from small community water supplies.** Kinner, N.E.; Quern, P.A.; Schell, G.S.; Lessard, C.E.; Clement, J.A. New Hampshire Univ., Durham, NH (USA). 1989. 16p. Available from NTIS, PC A03/MF A01.

Radon contamination of drinking water primarily affects individual homeowners and small communities using ground-water supplies. Presently, three types of treatment processes have been used to remove radon: granular activated carbon adsorption (GAC), diffused-bubble aeration, and packed-tower aeration. In order to obtain data on these treatment alternatives for small communities water supplies, a field evaluation study was conducted on these three processes as well as on several modifications to aeration of water in storage tanks considered to be low cost/low technology alternatives. The paper presents the results of these field studies conducted at a small mobile home park in rural New Hampshire. The conclusion of the study was that the selection of the appropriate treatment system to remove radon from drinking water depends primarily upon: (1) precent removal of process; (2) capital operating and maintenance costs; (3) safety (radiation); and (4) raw water quality (Fe, Mn, bacteria and organics).

20395 (PB–90-129347/XAB) **Persistence of chlorinated hydrocarbon contamination in a California marine ecosystem.** Young, D.R.; Gossett, R.W.; Heesen, T.C. Southern California Coastal Water Research Project Authority, Long Beach, CA (USA). 1989. 12p. Available from NTIS, PC A03/MF A01.

Pub. in Oceanic Processes in Marine Pollution, Chapter 3, Vol. 5, 33-41(1989).

Despite major reductions in the dominant DDT and polychlorinated biphenyls (PCB) input off Los Angeles (California, U.S.A.) in the early 1970s, the levels of these pollutants decreased only slightly from 1972 to 1975 both in surficial bottom sediments and in a flatfish bioindicator (Dover sole, Microstomus pacificus) collected near the submarine outfall. Concentrations of these pollutants in the soft tissues of the mussel Mytilus californianus, collected intertidally well inshore of the highly contaminated bottom sediments, followed much more closely the decreases in the outfall discharges. These observations suggest that contaminated sediments on the seafloor were the principal (although not necessarily direct) cause of the relatively high and persistent concentrations of DDT and PCB residues in tissues. The study indicated that residues of the higher-molecular-weight chlorinated hydrocarbons, such as DDT and PCB, can be highly persistent once released to coastal marine ecosystems and that their accumulation in surficial bottom sediments is the most likely cause of this persistence observed in the biota of the discharge zone.

20396 (PB–90-129800/XAB) **Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (mid-Atlantic). Weakfish.** Mercer, L.P. North Carolina Div. of Marine Fisheries, Morehead City, NC (USA). Aug 1989. 26p. Available from NTIS, PC A03/MF A01.

See also PB–90-129792.

Species profiles are literature summaries of the taxonomy, morphology, range, life history, and environmental requirements of coastal aquatic species. They are designed to assist in environmental-impact assessment. Weakfish are one of the most abundant fishes in the estuarine and nearshore waters of the Atlantic coast. Weakfish mature at age I throughout their range and spawning takes place in coastal and estuarine waters from March to September. Juveniles utilize the deeper areas within estuaries.

20397 (PB–90-853987/XAB) **Chesapeake Bay pollution studies. June 1971-November 1989 (Citations from the NTIS data base). Report for June 1971-November 1989.** National Technical Information Service, Springfield, VA (USA). Dec 1989. 149p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning Chesapeake Bay basin and wetlands pollution studies. From the identification and monitoring of water pollution sources to the initiation and enforcement of new environmental laws and programs, this bibliography will benefit those who are actively engaged in quality-assessment programs as well as concerned environmentalists. The importance of this ecosystem as a marine nursery is now understood and, therefore, to a lesser extent this bibliography reflects the new restoration and protection plans being developed by the adjoining states of Maryland and Virginia. (Contains 288 citations fully indexed and including a title list.)

20398 (PB–90-855057/XAB) **Biofiltration. December 1977-December 1989 (Citations from the Selected Water Resources Abstracts data base). Report for December 1977-December 1989.** National Technical Information Service, Springfield, VA (USA). Dec 1989. 51p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning the use of microbiological populations in conjunction with filter media to remove organic, inorganic, and biological contaminants in water and waste water. Filter media used include sand, carbon, plastic, rock, and wood. Common applications of this process are in municipal and industrial waste water treatment, filtration of ground water and landfill leachate, and water recirculation systems. (Contains 69 citations fully indexed and including a title list.)

20399 (PB–90-855289/XAB) **Water Quality Acts: Standards, regulations, and reactions. January 1970-December 1989 (Citations from Pollution Abstracts). Report for January 1970-December 1989.** National Technical Information Service, Springfield, VA (USA). Dec 1989. 135p. Available from NTISPC N01/MF N01.

Supersedes PB–87-868816.

This bibliography contains citations concerning standards, regulations, and public and special interest reactions to various water-quality acts or laws. Technical, environmental, economic, and political aspects of these laws are considered. Attention is also given to methods and problems of implementation and enforcement. (This updated bibliography contains 391 citations, 67 of which are new entries to the previous edition.)

20400 (PB–90-855503/XAB) **Dredging: Technology and environmental aspects. May 1978-July 1989 (Citations from the Life Sciences Collection data base). Report for May 1978-July**

1989. National Technical Information Service, Springfield, VA (USA). Dec 1989. 166p. Available from NTISPC N01/MF N01.

Supersedes PB-89-854137.

This bibliography contains citations concerning the technology and environmental impacts of dredging. Equipment, including semi-submersible cutter platforms, is described. Sediment movement, factors affecting sediment movement, and the disposal of dredged material, are discussed, and computer models predicting the fate of the dredged materials are considered. The environmental impacts of the dredged areas and the effects of ocean dumping of dredged material are also discussed. (This updated bibliography contains 352 citations, 22 of which are new entries to the previous edition.)

20401 (PNL-7215) **Natural groundwater recharge and water balance at the Hanford Site.** Rockhold, M.L.; Fayer, M.J.; Gee, G.W.; Kanyid, M.J. Pacific Northwest Lab., Richland, WA (USA). Jan 1990. 69p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC06-76RL01830. Order Number DE90005826. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

The purpose of this report is to present water-balance data collected in 1988 and 1989 from the 300 Area Buried Waste Test Facility and Grass Site, and the 200 East Area closed-bottom lysimeter. This report is an annual update of previous recharge status reports by Gee, Rockhold, and Downs, and Gee. Data from several other lysimeter sites are included for comparison. 43 refs., 28 figs., 7 tabs.

20402 (SFB-210/A-42, pp. 215-226) **Calculation of flow and sedimentation processes in settling basins.** Rodi, W.; Celik, I.; Adams, E.W.; Lyn, D. Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke. Mar 1988. (In German). In *Work and result report of Special Research Area 210 for the years 1985-1987.* Available from Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke. Available from Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke.

The target of this project is to develop a numerical process by which the effect of the most important parameters such as the basin, incoming and outgoing geometry, flow rate, differences in density, concentration of solids and size distribution on the method of operation of the settling basin can be determined. In the second period, in parallel with the development of computer programs, supporting laboratory measurements are made in a model basin, where the complexity of the phenomena to be examined is systematically increased, i.e.: first clear water experiments are made at constant density, then experiments with the addition of salt water to simulate density flows and finally experiments with the introduction of solids (sand). (orig./KW).

20403 **Small-diameter casing for standpipe monitoring wells: A comparison of current alternatives.** Schalla, R. (Pacific Northwest Lab., Richland, WA (USA)); Myers, D.A. pp. 597 of Proceedings of the second national outdoor action conference on aquifer restoration, ground water monitoring and geophysical methods. Volume I. National Water Well Association, Dublin, OH (US) (1988). DOE Contract AC06-76RL01830. (CONF-8805312--: 2. national outdoor action conference on aquifer restoration, ground water monitoring and geophysical methods, Las Vegas, NV (USA), 23-26 May 1988).

The standpipe monitoring well is the most common and accepted system for monitoring the chemical quality of ground water. The majority of these wells have a diameter of 2 inches or less. The lower cost of the small-diameter wells makes them the preferred choice. However, the technology available to properly develop, sample, and monitor such wells has evolved gradually over the last several years, and with it changes and improvements have been made in the design of the standpipe monitoring well. The variety of threaded couplings used to join sections of casing or screen are quite diverse, and current designs of the flush-threaded type are surprisingly incompatible. The designs differ in the types of threading and seals, the variety of materials, the actual pipe and coupling lengths, the pipe thickness (schedule), and pipe cleaning procedures. National design standards are needed for flush-threaded casing used to construct monitoring wells.

20404 **Variability of metals and metallothionein in mussels from San Francisco and Tomales bays.** Knezovich, J.P. (Lawrence Livermore National Lab., CA (USA)); Novacek, J.M.; Harrison, F.L. *Preprints of Papers Presented at National Meeting, Division of Water, Air and Waste Chemistry, American Chemical Society (USA),* 28(2): 274 (Sep 1988). DOE Contract W-7405-ENG-48. (CONF-8909236--: JAERI/EPA workshop on residual radiation and recycle criteria, St. Michaels, MD (USA), 27-28 Sep 1989).

The bay mussel, Mytilus edulis, has been used widely as an indicator of metal contamination in the marine environment. However, factors affecting the variability of metals and metallothionein (MT) concentrations in these organisms are poorly understood and must be defined before metal and MT levels can be used as valid indices of environmental contamination. They authors studied mussels from a relatively pristine environment (Tomales Bay) and a metal-contaminated region of San Francisco Bay. Data obtained from monthly sampling over a two-year period indicated that significant differences in metal and MT concentrations occur seasonally in native populations of mussels and that the dynamics of change are not the same. In mussels transplanted from Tomales Bay to San Francisco Bay, evidence for the induction of MT was obtained and metal and MT levels reflected the change in their environment as well as seasonal changes.

20405 **Multiple biological responses in starry flounder to chemical contamination in San Francisco bay.** Spies, R.B. (Lawrence Livermore National Lab., CA (USA)); Rice, D.W. Jr.; Thomas, P.J.; Stegeman, J.J.; Woodin, B.; Cross, J.N.; Hose, J.E. *Preprints of Papers Presented at National Meeting, Division of Water, Air and Waste Chemistry, American Chemical Society (USA),* 28(2): 310 (Sep 1988). (CONF-8909236--: JAERI/EPA workshop on residual radiation and recycle criteria, St. Michaels, MD (USA), 27-28 Sep 1989).

In this field study of the response of starry flounder to contaminants in San Francisco Bay multiple biological and chemical measures were made, emphasizing potential effects on reproductive fitness. Fish collected from stations in the central, more urbanized portion of San Francisco Bay had higher hepatic concentrations of selective highly chlorinated PCB congeners; hepatic microsomal P-450E was correspondingly elevated. Circulating steroids did not generally differ between sites, with the exception of elevated estradiol at one central bay site in immature females. In this group plasma estradiol concentrations were positively correlated with hepatic microsomal P-450E concentrations. The occurrence of micronuclei in circulating erythrocytes was elevated at all bay sites relative to the coastal site.

20406 **Analysis of blood biomarkers from bluegill sunfish.** Gettys, C.E. (Western North Carolina Univ., Cullowhee (USA)); Shugart, L.R.; Gustin, M.K. *Preprints of Papers Presented at National Meeting, Division of Water, Air and Waste Chemistry, American Chemical Society (USA),* 28(2): 357-358 (Sep 1988). DOE Contract AC05-84OR21400. (CONF-8909236--: JAERI/EPA workshop on residual radiation and recycle criteria, St. Michaels, MD (USA), 27-28 Sep 1989).

The test animal for this project was a hybrid of the bluegill sunfish, Lepomis machrochirus. These fish were lab-reared and maintained in large, flow-through tanks at 10 C. The chemical benzo(a)pyrene (BaP) was used in the experiments. It is a carcinogen found in the environment most often as a by product of combustion of organic material. BaP is also an inducer of the mixed function oxidase system, which is the organisms detoxification system and which produces metabolites of the original chemicals. It is these metabolites which have the potential to interact with the DNA. The toxicant was present in the water at approximately 1 ppb. This was obtained by passing water through a generator column of glass beads, to which BaP had been adsorbed. This was a long-term, low level chronic exposure. Two procedures were used to evaluate the effects of BaP on the fish.

The DNA of the livers was examined for strand breaks by the alkaline unwinding assay and the nuclei of the whole blood cells were examined for abnormalities by flow cytometry.

55 BIOMEDICAL SCIENCES, BASIC STUDIES

5502 Biochemistry

Refer also to citation(s) 19471, 20126, 20422, 20484, 20486

20407 (ANL–89/42) **An automated procedure for covariation-based detection of RNA structure.** Winker, S.; Overbeek, R.; Woese, C.R.; Olsen, G.J.; Pfluger, N. Argonne National Lab., IL (USA). Dec 1989. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. Order Number DE90006462. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper summarizes our investigations into the computational detection of secondary and tertiary structure of ribosomal RNA. We have developed a new automated procedure that not only identifies potential bondings of secondary and tertiary structure, but also provides the covariation evidence that supports the proposed bondings, and any counter-evidence that can be detected in the known sequences. A small number of previously unknown bondings have been detected in individual RNA molecules (16S rRNA and 7S RNA) through the use of our automated procedure. Currently, we are systematically studying mitochondrial rRNA. Our goal is to detect tertiary structure within 16S rRNA and quaternary structure between 16S and 23S rRNA. Our ultimate hope is that automated covariation analysis will contribute significantly to a refined picture of ribosome structure. Our colleagues in biology have begun experiments to test certain hypotheses suggested by an examination of our program's output. These experiments involve sequencing key portions of the 23S ribosomal RNA for species in which the known 16S ribosomal RNA exhibits variation (from the dominant pattern) at the site of a proposed bonding. The hope is that the 23S ribosomal RNA of these species will exhibit corresponding complementary variation or generalized covariation. 24 refs.

20408 (BNL–43231-1) **Lesion measurement in nonradioactive DNA by quantitative gel electrophoresis.** Sutherland, J.C.; Chen, Chun Zhang; Emrick, A.; Hacham, H; Monteleone, D.; Ribeiro, E.; Trunk, J.; Sutherland, B.M. Brookhaven National Lab., Upton, NY (USA). 1989. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (BIO–4558;CONF-8910354–1: DNA damage and repair in human tissues conference, Upton, NY (USA), 1-4 Oct 1989). Order Number DE90007891. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The gel electrophoresis method developed during the past ten years in our laboratories makes possible the quantitation of UV induced pyrimidine dimers, gamma ray induced single- and double-strand breaks and many other types of lesions in nanogram quantities of DNA. The DNA does not have to be labeled with radionuclides or of a particular conformation, thus facilitating the use of the method in measuring damage levels and repair rates in the DNA of intact organisms – including man. The gel method can quantitate any lesion in DNA that either is, or can be converted to a single- or double-strand break. The formation of a strand break produces two shorter DNA molecules for each molecule that existed before the treatment that produced the break. Determining the number of breaks, and hence the number of lesions, becomes a matter of comparing the average lengths of molecules in samples differing only in lesion-induced breaks. This requires that we determine the distribution of mass of DNA on a gel as a function of its distance of migration and also the dispersion function of its distance of migration and also the dispersion function (the relationship between molecular length and distance of migration) in the gel electrophoresis system. 40 refs., 5 figs.

20409 (CONF-8911146–7) **Insertional mutagenesis in transgenic mice.** Woychik, R.P.; Beatty, B.R.; McKinney, W.L.; Andreadis, D.K.; Chang, A.J.; Barker, P.E. Oak Ridge National Lab., TN (USA). [1989]. 8p. Sponsored by U.S. DOE Energy Research; National Institute of Environmental Health Sciences. DOE Contract AC05-84OR21400. From Banbury Center conference on mutation induction and heritability in mammalian germ cells; Cold Spring Harbor, NY (USA); 12-15 Nov 1989. Order Number DE90007129. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A considerable effort is under way in medicine and biology to characterize the genes associated with development in humans and other species. An important feature of much of this research involves the molecular analysis of mutations because the alteration in gene expression associated with mutations is, in many cases, the basis for establishing the normal function of individual genes. In fact, the remarkable recent success in characterizing genes with specific functions in yeast, C. elegans, and Drosophila followed from earlier genetic analyses, and from the availability of mutations in these organisms that could be analyzed at the molecular level. The mouse, with its well-characterized genetic makeup and accessibility to experimental manipulation, is a good system for studying genes with specific functions in mammals. Many spontaneous, and chemical- or radiation-induced mutations are being studied at the molecular level to learn more about the structure and expression of genes regulating complex developmental processes. However, to be able to use mutations to characterize genes with specific functions, molecular probes must be available to facilitate the cloning and structural characterization of the mutant loci. 18 refs.

20410 (PB–90-129438/XAB) **Improved method for the direct determination of cadmium in biological materials by atomic absorption spectrophotometry.** Blackstone, M.; Kaplan, P.; Richdale, N. Cincinnati Univ., OH (USA). Kettering Lab. 1989. 15p. Available from NTIS, PC A03/MF A01.

A method was presented for the determination of metals in mammalian tissues using an atomic absorption method. The procedure calls for digestion of the sample with a quaternary ammonium hydroxide. With the method one can measure metals which are normally present in low concentrations such as cadmium and nickel with significant sensitivity and a minimal amount of sample handling. Two month old rats were exposed through inhalation to cadmium-oxide aerosols daily for 8 hour periods. The precision of the method was determined in repeated analyses of control and exposed lung tissue. All lungs were divided into approximately five equal portions and each portion analyzed for cadmium, nickel, and zinc. To determine cadmium and nickel concentrations, 200 to 300 milligrams of wet tissue are needed for precision. These weights can be reduced to 1/20 for the analysis of zinc and copper. The absorbed amounts were small, suggesting that if the cadmium-oxide aerosol was absorbed, it was also effectively cleared from the system.

20411 (PB–90-853748/XAB) **European biotechnology. April 1978–July 1989 (Citations from the Life Sciences Collection data base). Report for April 1978–July 1989.** National Technical Information Service, Springfield, VA (USA). Dec 1989. 62p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning agricultural and pharmaceutical biotechnical research and development being conducted by Western European nations. Topics include: the future of biotechnology, recent developments, genetic analysis and manipulation (biomolecular engineering), and the biological production of pesticides and medicinals. This bibliography will be especially useful to R&D professionals and advanced biochemistry students entering the biomedical or agricultural fields. (Contains 134 citations fully indexed and including a title list.)

20412 (PB–90-853763/XAB) **European biotechnology: Business aspects. March 1985-November 1989 (Citations from the Biobusiness data base). Report for March 1985-November 1989.** National Technical Information Service, Springfield, VA (USA). Dec 1989. 145p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning business issues of biotechnological research and development (R&D) being conducted primarily in Western Europe. The major emphasis is on commercial agricultural and pharmaceutical R&D companies. Business topics such as location, product technology, marketing strategies, sales statistics, competitive issues and market share, and consumption data are covered. Collaborative agreements between biotechnology

firms located in Western Europe and leading biotechnology companies around the globe are also cited. This bibliography is germane to the upcoming consolidation of the European Economic Community (EEC) and is of interest to biotechnology companies whose business/marketing plans include possible expansion into the EEC. (Contains 286 citations fully indexed and including a title list.)

20413 (PB–90-854050/XAB) **Biotechnology: Japan. March 1985-November 1989 (Citations from the Biobusiness data base). Report for March 1985-November 1989.** National Technical Information Service, Springfield, VA (USA). Dec 1989. 115p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning Japanese commercial agricultural and pharmaceutical biotechnology research and development. The major emphasis of this bibliography is on Japanese/U.S. cooperative agreements with discussion of patent rights, bulk pharmaceutical production facilities, bi-national technology transfer activities, and related topics. Some attention is given to Japanese industrial and governmental efforts to garner and protect new biotechnical processes and applications. This bibliography will be useful to individuals and organizations seeking biotechnical opportunities with Pacific Rim countries. (Contains 238 citations fully indexed and including a title list.)

20414 Role a Agrobacterium tumefaciens ChvA protein in export of β-1,2-glucan. Cangelosi, G.A. (Univ. of Washington, Seattle (USA)); Martinetti, G.; Leigh, J.A.; Lee, Chi Chang; Theines, C. *Journal of Bacteriology (USA),* 41(3): 1609-1615 (Mar 1989). DOE Contract FG06-86ER13532.

Functional chvA and chvB genes are required for attachment of Agrobacterium tumefaciens to plant cells, an early step in crown gall tumor formation. Strains defective in these loci do not secrete normal amounts of cyclic β-1,2-glucan. Whereas chvB is required for β-1,2-glucan synthesis, the role of chvA in glucan synthesis or export has not been clearly defined. We found that cultures of chvA mutants contained as much neutral β-1,2-glucan in the cell pellets as did the wild type, with no detectable accumulation of glucan in the culture supernatant. The cytoplasm of chvA mutant cells contained over three times more soluble β-1,2-glucan than did the cytoplasm of the wild-type parent. Unlike the wild type, chvA mutants contained no detectable periplasmic glucan. The amino acid sequence of chvA is highly homologous to the sequences of bacterial and eucaryotic export proteins, as observed previously in the case of ndvA, a rhizobial homolog of chvA. Strong sequence homology within this family of export proteins is concentrated in the carboxy-terminal portions of the proteins, but placement of consensus ATP-binding sites, internal signal sequences, and hydrophobic domains are conserved over their entire lengths. These data suggest a model for β-1,2-glucan synthesis in A. tumefaciens in which glucan is synthesized inside the inner membrane with the participation of ChvB and transported across the inner membrane with the participation of ChvA.

20415 Mutation of Bacillus firmus OF4 to duramycin resistance result in substantial replacement of membrane lipid phosphatidylethanolamine by its plasmalogen form. Clejan, S. (City Hospital Center at Elmhurst, New York, NY (USA)); Guffanti, A.A.; Cohen, M.A.; Krulwich, T.A. *Journal of Bacteriology (USA),* 41(3): 1744-1746 (Mar 1989). DOE Contract AC02-81ER10871.

Mutant strains of alkalophilic Bacillus firms OF4 that were selected for resistance to duramycin had greatly reduced levels of membrane diacylphosphatidylethanolamine, as had been found in studies of such mutants of Bacillus subtilis. In the B. firmus strains, however, substantial levels of plasmenylethanolamine were found. This is an unusual membrane component for an aerobic eubacterium, but the presence of trace amounts even in the wild type was confirmed in experiments with $^{32}P_i$-labeled growth medium. The membrane lipid composition of the duramycin-resistant strains had several other changes that also left alkalophilic growth unimpaired.

20416 Enzymatic synthesis of a novel acetylated neutral lipid (related to platelet activating factor, PAF) by acyl-CoA: 1-alkyl-2-acetyl-sn-glycerol acyltransferase. Kawasaki, Tomio (Oak Ridge Associated Univ., TN (USA)); Synder, F. *FASEB (Federation of American Societies for Experimental Biology) Journal (USA),* 46(6): 2033 (1 May 1987). (CONF-870644–: 78. annual meeting of the American Society of Biological Chemists conference, Philadelphia, PA (USA), 7-11 Jun 1987).

Recent data from our laboratory have described the complete enzymatic steps for the de novo synthesis of alkylacetylglycerols and their subsequent conversion to PAF. Experiments are reported here to show that the alkylacetylglycerols also are a substrate for an acyltransferase. Homogenates of HL-60 cells produced labeled 1-alkyl-2-acetyl-3-acyl-sn-glycerols from 1-[^{3}H]hexadecyl-2-acetyl-sn-glycerol, 1-alkyl-2-[^{3}H]acetyl-sn-glycerol, or [1-^{14}C]linoleic acid when incubated with CoA (0.1 mM), ATP (10 mM), and Mg^{2+} (95 mM). Formation of labeled alkylacetylacyl-glycerols by the acyltransferase required CoA, ATP, and Mg^{2+}. The labeled alkylacetylacylglycerol produced had an identical R_f to that of an authenic standard; after treatment with pancreatic lipase, the sn-3 acyl moiety was hydrolyzed to regenerate the original 1-alkyl-2-acetyl-sn-glycerol precursor. [1-^{14}C]Linoleic acid was an excellent substrate for the acylation step, whereas [1-^{14}C]oleic acid was barely utilized. Kinetic properties and related characteristics of this enzyme that forms the acetyl analog of a triglyceride will be presented. Although the function of this new type of acetylated neutral lipid class is presently unknown, it could serve as a potential precursor reservoir in the de novo route of PAF synthesis.

20417 Formation of the chlorophyll precursor γ-aminolevulinic acid in cyanobacteria requires aminoacylation of a tRNA^{Glu} species. O'Neil, G.P. (Yale Univ., New Haven, CT (USA)); Peterson, D.M.; Schoen, A., Chen, Minwei; Soell, D. *Journal of Bacteriology (USA),* 170(9): 3810-3816 (Sep 1988).

In the chloroplasts of higher plants and algae, the biosynthesis of the chlorophyll precursor γ-aminolevulinic acid (ALA) involves at least three enzymes and a tRNA species. Here we demonstrate that in cell extracts of the unicellular cyanobacterium Synechocystis sp. strain PCC 6803 ALA was formed from glutamate in a series of reactions in which activation of glutamate by glutamyl-tRNA^{Glu} formation was the first step. The activated glutamate was reduced by a dehydrogenase which displayed tRNA sequence specificity. Fractionation of strain 6803 tRNA by reverse-phase chromatography and polyacrylamide gel electrophoresis yielded two pure tRNA^{Glu} species which stimulated ALA synthesis in vitro. These tRNAs had identical primary sequence but differed in the nucleotide modification of their anticodon. The 6803 tRNA^{Glu} was similar to the sequence of tRNA^{Glu} species or tRNA genes from Escherichia coli and from chloroplasts of Euglena gracilis and higher plants. Southern blot analysis revealed at least two tRNA^{Glu} gene copies in the 6803 chromosome. A glutamate-1-semialdehyde aminotransferase, the terminal enzyme in the conversion of glutamate to ALA in chloroplasts, was detected in 6803 cell extracts by the conversion of glutamate-1-semialdehyde to ALA and by the inhibition of this reaction by gabaculin.

20418 Identification of a celE-binding protein and its potential role in induction of the celE gene in Thermomonospora fusca. Lin, E. (Cornell Univ., Ithaca, NY (USA)); Wilson, D.B. *Journal of Bacteriology (USA),* 170(9): 3843-3846 (Sep 1988). DOE Contract FG02-84ER13233.

Thermomonospora fusca cellulase E_5 is encoded by the celE gene. This appears to be regulated at the transcriptional level by both induction and repression, and three putative closely linked promoters have been located by S1 mapping. To study its regulatory mechanism, a gel retardation assay was used to identify a protein in T. fusca cell extracts that interacted specifically with the DNA fragment containing the celE promoters. It was found that the binding activity appeared only when cellulase synthesis was induced, and it therefore resembled an activator protein involved in cellulase induction. DNase I footprinting identified the target sequence for this protein as a 21-base-pair sequence downstream from the putative celE promoters. The level of this protein was measured in two cellulase constitutive mutants, and the results suggest a complex control for celE induction.

20419 Transcription of the celE gene in Thermomonospora fusca. Lin, E. (State Univ. of New York, Brooklyn (USA)); Wilson, D.B. *Journal of Bacteriology (USA),* 170(9): 3838-3842 (Sep 1988).

The steady-state level of celE mRNA (coding for cellulase E_5) in Thermomonospora fusca YX was measured by Northern (RNA

blot) hybridization under conditions causing induction or repression of cellulase synthesis. A good correlation was found between the mRNA level of cellulase E_5, suggesting that the T. fusca celE gene is regulated at the level of mRNA and, most likely, at the level of transcription. The 5′ and 3′ ends of the celE gene transcription unit were determined by S1 mapping with single-stranded DNA probes. These results showed that there were three species of celE mRNA in T. fusa YX with closely spaced 5′ ends and identical 3′ ends. The size of each mRNA was about 1.5 kilobases, from both the Northern and S1 data. This size is only slightly longer than that required to code for the 45-kilodalton E_5 protein. In Escherichia coli D318 (celE), the 5′ ends of the celE mRNAs are identical to those in T. fusca, but the 3′ ends are located ca. 300 base pairs upstream of the T. fusca 3′ end. The region where the putative celE promoters were located had some interesting features, including a 60-base-pair A + T-rich sequence and sequence resembling σ^{60} promoters.

20420 **DNA binding protein.** Pastan, I.; Kageyama, R. To National Cancer Inst., Bethesda, MD. A 7-441,912. 28 Nov 1989. 43p. Available from NTISPC N03/MF A01.

This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of application available NTIS.

The invention to a DNA binding protein, and, in particular, to a DNA binding protein that represses transcription from promoters to which it binds. The invention further relates to a DNA sequence encoding the DNA binding protein, to a recombinant DNA molecule that includes such a sequence and to cells transformed therewith. The invention further relates to a method of regulating gene expression.

20421 **SCL (stem cell leukemia) gene, and a hematopoietic growth and differentiation factor encoded thereby.** Kirsch, I.R.; Begley, C.G. To National Institutes of Health, Bethesda, MD. USA Patent Application 7-437,819. 17 Nov 1989. 39p. Available from NTISPC N03/MF A01.

This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of application available NTIS.

A new human gene, SCL, was identified. The gene was discovered because of its involvement in a chromosomal translocation associated with the occurrence of a stem cell leukemia manifesting myeloid and lymphoid differentiation capabilities. The sequence of a cDNA for the normal SCL transcript is reported, as well as for an aberrant fusion transcript produced in the leukemic cells. Although different at their 3' untranslated regions, both cDNAs predict a protein within which is contained a region of primary amino acid sequence homology to the previously described amphipathic helix-loop-helix DNA binding and dimerization motif also contained within a variety of proteins whose role in development, differentiation, and proliferation has already been established.

5504 Genetics

Refer also to citation(s) 19179, 20419, 20420, 20421

20422 (AD-A–214029/1/XAB) **Advanced biosensors for amino acid detection. Phase 1. Report for 1-31 October 1989.** Cook, R.L.; Patel, J.; Sammells, A.F. Eltron Research, Inc., Aurora, IL (USA). 31 Oct 1989. 11p. Available from NTIS, PC A03/MF A01.

Reported here is work directed towards characterizing an advanced biosensor technology compatible for the real-time indirect optical detection of amino acids as typified by e-phenylalanine, e-doA, E-Tryptophan and related compounds. The technical strategy involves the indirect optical detection of amines and amino acids by monitoring changes induced in the visible spectra of immobilized chromagenic acyclic polyether host molecules to which the amine or amino acid becomes associated. Syntheses are currently proceeding for preparation of chromagenic acyclic polyether host molecules into which selected amino acids will become incorporated, resulting in induced color changes, detectable when these molecular species are immobilized onto a fiber optic. Design and fabrication of synchronous sample-and-hold circuitry for detection of small optical changes from the fiber optic has largely been completed.

20423 (AD-A–214281/8/XAB) **In vitro expression and mutagenesis of a gene for corticotropin releasing factor. Annual report, November 1988-October 1989.** Vrana, K.E. West Virginia Univ., Morgantown, WV (USA). Dept. of Biochemistry. 31 Oct 1989. 13p. Available from NTIS, PC A03/MF A01.

The specific goals of this proposal are to: (1) create a recombinant gene for corticotropin releasing factor (CRF), (2) express that gene by in vitro transcription and translation, (3) test the function of this recombinant protein by receptor binding assay and agonist-induced release of ACTH from cultured pituitary cells and (4) create and test mutants of the CRF molecule (starting at the level of the DNA). The author have accomplished the first two of these goals and partially completed the third. He has have synthesized the CRF gene, expressed it and characterized the recombinant protein. This protein is active when applied to pituitary cells, but the in vitro translation extract contains substances which partially interfere with that activity. He is are presently purifying the recombinant protein from the translation extract. In a related area, he is are conducting experiments to characterize the stress non-responsive period (SNRP) in the neonatal rat. It has been found find that the spontaneously hypertensive rat (SHR) is not entirely subject to this quiescent adrenocortical period (during the first two weeks of neonatal life) when compared with the normotensive control animal. This difference is not caused by alterations in the levels of circulating (or stored) ACTH, implying that there are differences in the responsiveness of the adrenal cortex.

20424 (PB–90-129495/XAB) **Mechanisms of DNA utilization by estuarine microbial populations.** Paul, J.H.; DeFlaun, M.F.; Jeffrey, W.H. University of South Florida, St. Petersburg, FL (USA). Dept. of Marine Science. c 1988. 9p. Available from NTIS, PC A02/MF A01.

Pub. in Applied and Environmental Microbiology, Vol. 54, No. 7, 1682-1688(Jul 1988).

The mechanisms of utilization of DNA by estarine microbial populations has been investigated by competition experiments and DNA uptake studies. Deoxyribonucleoside monophosphates (dNMP's), thymidine, thymine, and RNA all competed with the uptake of radioactivity from (3H)DNA in 4-hour incubations. In fifteen-minute incubations, dNMP's had no effect or stimulated (3H)DNA binding, depending on concentration. Uptake of radioactivity from (3H)DNA resulted in little accumulation of TCA-soluble intracellular radioactivity, and was inhibited by the DNA synthesis inhibitor novobiocin. Molecular fractionation studies indicated that some radioactivity from (3H)DNA appeared in the RNA (10 and 30% at 4 and 24 h respectively) and protein (approximately 3%) fractions. The ability for esturine microbial assemblages to transport gene sequences was investigated by plasmid uptake studies followed by molecular probing.

20425 (PB–90-129529/XAB) **Hybridization of DNA probes with whole-community genome for detection of genes that encode microbial responses to pollutants: Mer genes and Hg (2+) resistance.** Barkay, T.; Liebert, C.; Gillman, M. Environmental Protection Agency, Gulf Breeze, FL (USA). Environmental Research Lab. c 1989. 6p. (EPA–600/J-89/167). Available from NTIS, PC A02/MF A01.

Pub. in Applied and Environmental Microbiology, Vol. 55, No. 6M 1574-1577(Jun 1989).

Nucleic acids extracted from microbial biomass were hybridized with probes representing four mer operons, to detect genes encoding adaptation to Hg^{2+}. An enrichment in sequences similar to the mer genes of transposon 501 occurred during adaptation in a freshwater community. In an estuarine community, all four mer genes were only slightly enriched, suggesting that additional, yet uncharacterized, mer genes encodeded adaptation to HG^{2+}.

5505 Metabolism

20426 **Pathway of ammonium assimilation in a marine diatom determined with the radiotracer ^{13}N.** Zehr, J.P. (State Univ. of New York, Stony Brook (USA)); Falkowski, P.G. *Journal of*

Phycology (USA), 24(4): 588-591 (Dec 1988). DOE Contract AC02-76CH00016.

In unicellular algae, ammonium can be assimilated into glutamate through the action of glutamate dehydrogenase (GDH) or into glutamine through the sequential activities of glutamine synthetase and glutamate 2-oxoglutarate amidotransferase (GS-GOGAT pathway). We have shown that the first radio-labeled product of assimilation of $^{13}NH_4^+$ ($t_{\frac{1}{2}}$ = 10 min) was glutamine in the marine diatom Thalassiosira pseudonana (Hustedt). When GS-GOGAT was inhibited with methionine sulfoximine, the incorporation of radioactivity into both glutamine and glutamate was blocked, implying that the radio-labeled glutamate is formed from glutamine. Glutamine was also the first labeled product when the intracellular concentration of ammonium was elevated by preincubation with unlabeled ammonium. The results indicate that the GS-GOGAT pathway is the primary pathway for the assimilation of nitrogen in T. pseudonana.

20427 **^{13}N isotope studies of glutamine assimilation pathways in Neurospora crassa.** Calderon, J. (Universidad Nacional Autonoma de Mexico, Morelos (Mexico)); Mora, J.; Cooper, A.J.L.; Gelbard, A.S. *Journal of Bacteriology (USA)*, 41(3): 1772-1774 (Mar 1989). DOE Contract FG02-86ER60407.

L-[amide-^{13}N]glutamine in Neurospora crassa is metabolized to [^{13}N]glutamate by glutamate synthase and to [^{13}N]ammonium by the glutamine transaminase-ω-amidase pathway. The [^{13}N]ammonium released is assimilated by glutamate dehydrogenase and glutamine synthetase, confirming the operation of a glutamine cycle. Most of the nitrogen is retained during cycling between glutamate and glutamine.

20428 **Regulation of carbon and electron flow in Propionispira arboris: Relationship of catabolic enzyme levels to carbon substrates fermented during propionate formation via the methylmalony coenzyme a pathway.** Thompson, T.E. (Univ. of Wisconsin, Madison (USA)); Zeikus, J.G. *Journal of Bacteriology (USA)*, 170(9): 3996-4000 (Sep 1988). DOE Contract FG02-85ER13376.

A detailed study of the glucose fermentation pathway and the modulation of catabolic oxidoreductase activities by energy sources (i.e., glucose versus lactate of fumarate) in Propionispira arboris was performed. ^{14}C radiotracer data show the CO_2 produced from pyruvate oxidation comes exclusively from the C-3 and C-4 positions of glucose. Significant specific activities of glyceraldehyde-3-phosphate dehydrogenase and fructose-1,6-bisphosphate aldolase were detected, which substantiates the utilization of the Embden-Meyerhoff-Parnas path for glucose metabolism. The methylmalonyl coenzyme A pathway for pyruvate reduction to propionate was established by detection of significant activities of methylmalonyl coenzyme A transcarboxylase, malate dehydrogenase, and fumarate reductase in cell-free extracts and by ^{13}C nuclear magnetic resonance spectroscpic demonstation of randomization of label from [2-^{13}C]pyruvate into positions 2 and 3 of propionate. The specific activity of pyruvate-ferredoxin oxidoreductase, malate dehydrogenase, fumarate reductase, and transcarboxylase varied significantly in cells grown on different energy sources. D-Lactate dehydrogenase (non-NADH linked) was present in cells of P. arboris grown on lactate but not in cells grown on glucose or fumarate. These results indicate that growth substrates regulate synthesis of enzymes specific for the methylmalonyl coenzyme A path initial substrate transformation.

5506 Medicine

Refer also to citation(s) 20041, 20257, 20462, 21051

20429 (IAEA-R–4143-F) **Graded hyperthyroidism and serum human chorionic gonadotropin concentration in patients with trophoblastic disease: Final report for the period 1 July 1986 - 30 April 1989.** Rajatanavin, R. Ramathibodi Hospital, Bangkok (Thailand). Div. of Endocrinology and Metabolism; International Atomic Energy Agency, Vienna (Austria). Nov 1989. 34p. Order Number DE90617722. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Serum thyroid hormone and basal and post TRH stimulated levels of TSH were measured in 48 female subjects of mean age 29.3 ± 9.2 and mean gravida 2.9 ± 2.6 with trophoblastic disease (TD), both benign and malignant. Normal pregnant women (n=21) served as controls. Twenty-five patients showed a normal response to TRH (Group i) while the rest (Group ii) had subnormal response while thyroid hormone levels were increased. Two subgroups iiA and iiB were formed within Group ii on the basis of the free T_4 levels (measured by equilibrium dialysis) falling below or above the 25th percentile. hCG levels were higher in Group ii than in Group i and a stepwise significant increase in the mean level of this hormone was observed in Group i to iiA and iiB. Significant correlation between hCG levels and those of thyroxine, free thyroxine, and triiodothyronine were found in TD patients as a whole, but not within the different subgroups. Clinical signs were minimal, with proximal muscle weakness and fine finger tumours observed in 10 patients in Group iiB. The study shows that the incidence of biochemical hyperthyroidism is higher than was reported before sensitive methods for TSH measurement were available, and postulates that increased hCG concentrations in themselves and/or abnormal metabolic variants of hCG produced by trophoblastic tumours may act as thyroid stimulators in this condition. 64 refs, 5 figs, 4 tabs.

20430 (INIS-mf–12514) **Determination of reference values of thyroid hormones in newborn children (Riobamba Hospitals).** Alvarez, Silvio. Convenio Espoch - Italia. Escuela Superior Politecnica de Chimborazo, Riobamba (Ecuador). Sep 1989. 42p. (In Spanish). Order Number DE90617580. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Reference values of thyroid hormones in newborn children were determined in neonates at two hospitals: Policlinic and Social Security at Riobamba city. The data was compared with international values and healthy adults. Altogether 248 samples of umbilical cord blood and 38 samples of vessel blood from adults were used. The thyroid profile (T3, T4, TSH and T3, RU) was determined through radioimmunoassay, RIAPC, LOTUS 123 and CHARTMASTER. The following values were obtained in newborn children: T4(ug/dl) = 10,8 + - 3,1 ; T3(ng/dl) = 41,8 + - 26,9; TSH(uUl/ml) 7,2 + - 6,5; <<<<<T3RU() = 22,6 + - 7,9. The data obtained were not significantly different from the international values. If we compare newborns with adults there is a high significant difference. Since the reference values found were trusty it was recommended to use them in medical diagnosis.

20431 **No-carrier-added [^{18}F]-N-fluoroalkylspiroperidols.** Shine, C.Y.; Wolf, A.P.; Bai, L.Q.; Teng, R.T. To Dept. of Energy, Washington, DC. USA Patent 4,871,527. 3 Oct 1989. Filed date 29 Apr 1987. USA Patent Application 7 043,824. Int. Cl. A61K 49/02; C07D 471/10. 12p. Available from Patent and Trademark Office, Box 9, Washington, DC 20232.

This patent describes radioligands labeled with the position emitting radionuclide [^{18}F] suitable for dynamic study in living humans with position emission transaxial tomography. These new [^{18}F]-N-fluoroalkylspiroperidols, wherein the alkyl group contains from 2-6 carbon atoms, exhibit extremely high affinity for the dopamine receptors and provide enhanced uptake and retention in the brain concomitant with reduced radiation burden. These characteristics all combine to make these new radioligands useful for mapping dopamine receptors in normal and disease states in the living brain. Additionally, a new synthetic procedure for these radioligands as well as a new procedure for preparing the radiolabeled alkyl halide alkylating reagents are disclosed.

5507 Microbiology

Refer also to citation(s) 19179, 19181, 19194, 19195, 19309, 19471

20432 (CONF-881205–5) **Gas, oil, and coal biotechnology: An emerging industry.** Akin, C. Institute of Gas Technology, Chicago, IL (USA). [1988]. 6p. Sponsored by Institute of Gas Technology. From Symposium on coal, oil, and gas biotechnology; New Orleans, LA (USA); 5-7 Dec 1988. Available from OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616.

This paper identifies some of the key elements of gas, oil, and coal biotechnology and highlights the challenges and opportunities presented by this new field of technology. 7 refs.

20433 (PB–90-129503/XAB) **Effect of protozoan predation on relative abundance of fast- and slow-growing bacteria.** Sinclair, J.L.; Alexander, M. Cornell Univ., Ithaca, NY (USA). Dept. of Microbiology. c 1989. 7p. Available from NTIS, PC A02/MF A01.

Pub. in Canadian Jnl. of Microbiology, Vol. 35, No. 5, 578-582(1989).

Survival of six bacterial species with different growth rates was tested in raw sewage and sewage rendered free of protozoa. When the six species were inoculated at the same densities into sewage containing protozoa, the three slow-growing species were rapidly eliminated, and two of the three fast-growing species survived in detectable numbers. It is suggested that in environments with intense protozoan predation, protozoa may alter composition of bacterial communities by eliminating slow-growing bacteria.

5508 Morphology

20434 **Theoretical factors in modeling polarized light scattering by arbitrary particles.** Singham, S.B. (Sherwin-Williams Company, Cleveland technical Center, 601 Canal Road, Cleveland, Ohio 44113 (US)). *Applied Optics (USA)*, 28(23): 5058-5064 (1 Dec 1989).

The coupled dipole method has been used to model the S_{34} scattering matrix element for particles of arbitrary shape. Comparison of the results of the approximate method with the exact theory for a sphere shows that the size of the units required for S_{34} is much smaller than the size required for calculating S_{11} with similar accuracy. Model calculations for chiral particles show that the S_{34} matrix element depends sensitively on the exact shape, size and optical properties of the scatterer.

5509 Pathology

Refer also to citation(s) 20309, 20468, 20475

20435 (PB–90-129065/XAB) **Health-hazard evaluation report HETA 88-266-1970, Glennwood Range, Delaware, Ohio.** Fleeger, A.K.; Deng, J.F. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). 1989. 21p. (HETA–88-266-1970). Available from NTIS, PC A03/MF A01.

A study was made of possible hazardous working conditions at Glennwood Range, Delaware, Ohio. Employees manufactured consumer gas and electric ranges. Several employees were suffering from skin disorders. Porcelain enamel paints were applied to range parts by either a dipping or flow coat process. The porcelain enamels contained chromium in the trivalent state. Oxidizers were added to the enamels, causing the potential for the trivalent chromium to change to a hexavalent state. The skin problems were found mainly among the ground-coat line workers who were responsible for hanging parts on hooks to enter a curing oven. Most workers did not wear protective rubber gloves. It was determined that holes had developed in the heating coils of the curing oven, producing open flames that had caused burn off on the parts, and sharp edges developed on hooks used to hang parts. Samples taken from the hooks used to hang the range parts showed chromium(VI) concentrations of 0.09 to 2.41 micrograms per milligram of sample. Chromium(VI) concentrations in matter scraped from the hooks ranged from 0.3 to 4.4 micrograms/milligram. Sharp edges on the hooks caused abrasions on the hands of the worker, allowing the chromium a direct route of entry beneath the skin surface, causing the ulcerations. A health hazard existed from exposure to chromium. Measures for oven maintenance and worker protection are recommended.

5510 Physiological Systems

Refer also to citation(s) 20479

5520 Public Health

Refer also to citation(s) 19699, 19813, 19814, 20279, 20280, 20281, 20282, 20283, 20284, 20286, 20290, 20291, 20293, 20294, 20295, 20296, 20435

20436 (PB–90-125394/XAB) **NIOSH (National Institute for Occupational Safety and Health) grants: Research and demonstration projects, annual report, fiscal year 1988.** National Inst. for Occupational Safety and Health, Atlanta, GA (USA). May 1989. 223p. (DHHS/PUB/NIOSH–89-117). Available from NTIS, PC A10/MF A02.

See also PB–89-152979.

Under the Occupational Safety and Health Act of 1970 and the Federal Mine Safety and Health Amendments Act of 1977, the National Institute of Occupational Safety and Health (NIOSH) conducted intramural and extramural research designed to improve the environment of the American worker. Projects dealt with the following program areas: Occupational lung disease in granite workers, poultry workers, semiconductor industry, cancer risk, byssinosis, radiation exposure, phosgene, lung clearance, textile workers, mineral exposure, hyperresponsiveness to ozone, coal workers respiratory disease, and immune responsiveness to chlorine; musculoskeletal injuries, back pain, lifting techniques, and grip strength; occupational cancers, traumatic injuries, disorders of reproduction, neurotoxic disorders, noise induced hearing loss, dermatologic conditions, psychological disorders, engineering control systems, respiratory research, and other occupational concerns, human metabolism of halothane, chromium toxicity, poison centers, polyimide sorbents, plasma proteins, and isocyanates. The report also included listings of grants active during fiscal year 1988, grant awards by program area, grant awards by region and state, grant number index, principal investigator index, and a grantee institution index.

5530 Agriculture and Food Technology

Refer also to citation(s) 19323, 20035, 20273, 20274, 20275

20437 (PB–90-854357/XAB) **Chernobyl nuclear accident: Effects on food. April 1986-November 1989 (Citations from the Food Science and Technology Abstracts data base). Report for April 1986-November 1989.** National Technical Information Service, Springfield, VA (USA). Dec 1989. 55p. Available from NTISPC N01/MF N01.

Supersedes PB–89-851141.

This bibliography contains citations concerning studies and measurements of the radioactive contamination by the Chernobyl nuclear reactor accident of food and the food chain. The studies cover meat and dairy products, vegetables, fish, food chains, and radioactive contamination of agricultural farms and lands. (This updated bibliography contains 108 citations, 43 of which are new entries to the previous edition.)

20438 (PB–90-854522/XAB) **Corrosion of food and beverage cans. January 1972-November 1989 (Citations from the Food Science and Technology Abstracts data base). Report for January 1972-November 1989.** National Technical Information Service, Springfield, VA (USA). Dec 1989. 129p. Available from NTISPC N01/MF N01.

Supersedes PB–88-862065.

This bibliography contains citations concerning the external and internal corrosion of food and beverage containers. The manufacture of tin and steel plate, and aluminum cans is discussed, and factors affecting pitting are considered. Food chemistry and shelf-life aspects are also evaluated. (This updated bibliography contains 290 citations, 65 of which are new entries to the previous edition.)

56 BIOMEDICAL SCIENCES, APPLIED STUDIES

5601 Radiation Effects

Refer also to citation(s) 19358, 19981, 20032, 20408

20439 (AD-A–214233/9/XAB) **Quantitative measurement of radiation-induced base products in DNA using gas chromatography-mass spectrometry.** Fuciarelli, A.F.; Wegher,

B.J.; Gajewski, E.; Dizdaroglu, M.; Blakely, W.F. Armed Forces Radiobiology Research Inst., Bethesda, MD (USA). 1989. 14p. (AFRRI-SR-89-30). Available from NTIS, PC A03/MF A01.

Pub. in Radiation Research, Vol. 119, 219-231(1989).

Gas chromatography-mass spectrometry with selected-ion monitoring was used to study radiation-induced damage to DNA. Quantitative analysis of modified purine and pyrimidine bases resulting from exposure to ionizing radiation using this technique is dependent upon the selection of appropriate internal standards and calibration of the mass spectrometer for its response to known quantities of the internal standards and the products of interest. The compounds 6-azathymine and 8-azaadenine were found to be suitable internal standards for quantitative measurements of base damage in DNA. For the purpose of calibration of the mass spectrometer, relative molar response factors for intense characteristics ions were determined for the trimethylsilyl derivatives of 5-hydroxyuracil, thymine glycol, and 5,6 dihydrothymine using 6-azathymine, and for the trimethylsilyl derivatives of 4,6-diamino-5-formamidopyrimidine, 8-hydroxyguanine using 8-azaadenine. Accurate measurements of the yield of radiation-induced modifications to the DNA bases is also dependent upon two chemical steps in which the purines and pyrimidines are released from the sugar-phosphate backbone and the derivatized to make them volatile for gas chromatography. The completeness of these reactions, in addition to assessing the stability of the modified DNA bases in acid and their trimethylsilylated derivatives over the time necessary to complete the experimental analysis, was also examined.

20440 (AD-A-214235/4/XAB) **Effects of acute sublethal gamma radiation exposure on aggressive behavior in male mice: A dose-response study.** Maier, D.M.; Landauer, M.R. Armed Forces Radiobiology Research Inst., Bethesda, MD (USA). Aug 1989. 6p. (AFRRI-SR-89-32). Available from NTIS, PC A02/MF A01.

Pub. in Aviation, Space and Environmental Medicine, 774-778(Aug 1989).

The resident-intruder paradigm was used to assess the effects of gamma radiation (0,3,5,7, Gray Gy cobalt-60) on aggressive offensive behavior in resident male mice over a 3-month period. The defensive behavior of nonirradiated intruder mice was also monitored. A dose of 3 Gy had no effect on either the residents' offensive behavior or the defensive behavior of the intruders paired with them. Doses of 5 and 7 Gy produced decreases in offensive behavior of irradiated residents during the second week postirradiation. The nonirradiated intruders paired with these animals displayed decreases in defensive behavior during this time period, indicating a sensitivity to changes in the residents' behavior. After the third week postirradiation, offensive and defensive behavior did not differ significantly between irradiated mice and sham-irradiated controls. This study suggests that sublethal doses of radiation can temporarily suppress aggressive behavior but have no apparent permanent effect on that behavior.

20441 (AD-A-214236/2/XAB) **Progressive behavioral changes during the maturation of rats with early radiation-induced hypoplasia of fascia dentata granule cells.** Mickley, G.A.; Ferguson, J.L.; Mulvihill, M.A.; Nemeth, T.J. Armed Forces Radiobiology Research Inst., Bethesda, MD (USA). 1989. 10p. (AFRRI-SR-89-33). Available from NTIS, PC A02/MF A01.

Pub. in Neurotoxicology and Teratology, Vol. 11, 385-393(1989).

Localized exposure of the neonatal rat brain to x rays produces neuronal hypoplasia specific to the granule cell layer of the hippocampal dentate gyrus. This brain damage causes locomotor hyperactivity, slowed acquisition of passive avoidance tasks and long bouts of spontaneous turning (without reversals) in a bowl apparatus. The authors report here how these behavioral deficits change as a function of subject aging and behavioral test replications. Portions of the neonatal rat cerebral hemispheres were X-irradiated in order to selectively damage the granule cells of the dentate gyrus. Rats between the ages of 71-462 days were tested 3 separate times on each of the following 3 behavioral tests: (1) spontaneous locomotion, (2) passive avoidance acquisition, and (3) spontaneous circling in a large plastic hemisphere. Rats with radiation-induced damage to the fascia dentata exhibited long bouts of slow turns without reversals. Once they began, irradiated subjects perseverated in turning to an extent significantly greater than sham-irradiated control subjects. The hyperactivity of the irradiated animals decreased significantly as they matured. These data suggest that radiation-induced damage to the fascia dentata produces task-dependent behavioral deficits that change as a function of subject age and/or behavioral testing.

20442 (AD-A-214329/5/XAB) **Assessment of the behavioral toxicity of high-energy iron particles compared to other qualities of radiation.** Rabin, B.M.; Hunt, W.A.; Joseph, J.A. Armed Forces Radiobiology Research Inst., Bethesda, MD (USA). 1989. 11p. (AFRRI-SR-89-35). Available from NTIS, PC A03/MF A01.

Pub. in Radiation Research, Vol. 119, 113-122(1989).

Conditioned taste aversion was used to evaluate the behavioral toxicity of exposure to high-energy iron particles (56Fe, 600 MeV/amu) in comparison to that of gamma photons (60 Co), high-energy electrons, or fission neutrons. Exposure to high-energy iron particles (5-500 cGy) produced a dose-dependent taste aversion with a maximal effect achieved with a dose of 30 cGy. Gamma photons and electrons were the least-effective stimuli for producing a conditioned taste aversion, with a maximal aversion obtained only after exposure to 500 cGy, while the effectiveness of fission neutrons was intermediate to that of photons and iron particles, and a maximal aversion was obtained with a dose of 100 CGy. In the second experiment, rats with lesions of the area postrema were exposed to iron particles (3- cGY), but failed to acquire a taste aversion. The results indicate that (1) high-energy iron particles are more toxic than other qualities of radiation and (2) similar mechanisms mediate the behavioral toxicity of gamma photons and high-energy iron particles.

20443 (AD-A-214330/3/XAB) **Induction of marrow hypoxia by radioprotective agents.** Allalunis-Turner, M.J.; Walden, T.L.; Sawich, C. Armed Forces Radiobiology Research Inst., Bethesda, MD (USA). 1989. 7p. (AFRRI-SR-89-26). Available from NTIS, PC A02/MF A01.

Pub. in Radiation Research, Vol. 118, 581-586(1989).

Many compounds that possess sulfhydryl groups have been shown to protect bone marrow from radiation injury. The most effective thiol radioprotective agent is ethiofos (S-2-(3-aminopropylamino)ethylphosphorothoic acid or WR-2721). The ability of thiol and non-thiol radioprotectors to induce hypoxia was determined using binding of (^{3}H)misonidazole by bone marrow cells as a measure of hypoxia. When administered at maximally radioprotective doses, four drugs (WR-2721, cysteamine, 5-hydroxytryptamine, and 16,16-dimethyl prostaglandin E2) significantly increased the amount of (^{3}H)misonidazole bound by marrow cells, while no significant increase in binding was observed with three other agents (endotoxin, AET, superoxide dimutase). Doses of WR-2721 previously shown to provide suboptimal radioprotection did not significantly increase ^{3}H-misonidazole binding. These results suggest that the physiological effects of some radioprotectors, that is, their ability to induce marrow hypoxia, may contribute to their efficacy in vivo.

20444 (AD-A-214331/1/XAB) **Cell-cycle radiation response: Role of intracellular factors.** Blakely, E.; Chang, P.; Lommel, L.; Bjornstad, K.; Dixon, M. Armed Forces Radiobiology Research Inst., Bethesda, MD (USA). 1989. 11p. (AFRRI-SR-89-27). Available from NTIS, PC A03/MF A01.

Pub. in Adv. Space Res., Vol. 9, No. 10, (10)177-(10)186(1989).

The quantitative understanding of long-term effects of the components of space radiation on carcinogenesis and nervous-system functions depends on the nature of the molecular injury produced by particles of various atomic numbers and energies. Of particular interest is the functional dependence of individual lesions, their repair and misrepair, and the time-dependent interactions that can occur at low dose rates. Both inherited genetic susceptibility as well as normal programmed genetic functions occurring during cell division could contribute to the vulnerability of cellular targets to damage from ionizing radiations. The authors have studied variations of radiosensitivity and endogenous cellular factors during the course of progression through the human and hamster cell cycle. After exposure to low-LET radiations, the most radiosensitive cell stages are mitosis and the G1/S interface. The increased activity of

a specific antioxidant enzyme such as superoxide dismutase in G1-phase, and the variations of endogenous thiols during cell division are thought to be intracellular factors of importance to the radiation-survival response. These factors may contribute to modifying the age-dependent yield of lesions or more likely, to the efficiency of the repair processes. Hazards posed by the interaction of damage from sequential doses of radiations of different qualities have been evaluated and are shown to lead to a cell-cycle-dependent enhancement of radiobiological effects. A summary comparison of various cell-cycle-dependent endpoints measured with low- or high-LET radiations is given and includes a discussion of the possible additional effects introduced by microgravity.

20445 (AD-A–214332/9/XAB) **Characteristics of radiation-induced performance changes in bar-press avoidance with and without a preshock warning cue.** Burghardt, W.F.; Hunt, W.A. Armed Forces Radiobiology Research Inst., Bethesda, MD (USA). 1989. 7p. (AFRRI-SR–89-28). Available from NTIS, PC A02/MF A01.

Pub. in Pharmacology Biochemistry and Behavior, Vol. 33, 549-554(1989).

Rats were trained to perform one of three tasks in which responses on a lever delayed the onset of footshock for 20 sec. One task provided a warning tone beginning 15 sec after the last response on the lever and lasting for 5 sec just prior to the presentation of a shock (fixed-interval signalled avoidance), while a second task provided no external cues (unsignalled avoidance). The third task was similar to the fixed-interval signalled avoidance task, except that the warning tone preceding shock began at varying intervals after the last response on the lever (variable-inteval signalled avoidance). Animals trained on the signalled avoidance paradigms received fewer shocks than those on the unsignalled avoidance paradigm. After 10 krads of gamma radiation, animals performing on either task with cues were less able to avoid shock, although they recovered somewhat over a 90-min period. The animals not provided cues also experienced more shocks during the first 10 min after irradiation but were relatively less affected in performing the task. Response rates on the bar and the patterns of responding on these tasks were not significantly different after irradiation, except that animals responded after the onset of shock more often after irradiation than before. These results suggest that rats will continue to effectively use task-related cues after irradiation, but that the relative degree of behavioral decrement may depend on the initial level of performance or possibly the complexity of the task.

20446 (AD-A–214333/7/XAB) **Radioprotection of mice with interleukin-1: Relationship to the number of spleen colony-forming units.** Schwartz, G.N.; Patchen, M.L.; Neta, R.; MacVittie, T.J. Armed Forces Radiobiology Research Inst., Bethesda, MD (USA). 1989. 13p. (AFRRI-SR–89-38). Available from NTIS, PC A03/MF A01.

Pub. in Radiation Research, Vol. 119, 101-112(1989).

Compared to saline-injected mice 9 days after 6.5-Gy irradiation, there were twofold more Day 8 spleen colony-forming units (CFU-S) per femur and per spleen from B6D2F1 mice administered a radioprotective dose of human recombinant interleukin-1-alpha (rIL-1) 20 h prior to their irradiation. Studies of this report compared the numbers of CFU-S in nonirradiated mice 20 h after saline or rIL-1 injection. Prior to irradiation, the number of Day 8 CFU-S was not significantly different in the bone marrow or spleens from saline-injected mice and rIL-1-injected mice. Also, in the bone marrow, the number of Day 12 CFU-S was similar for both groups of mice. Similar seeding efficiencies for CFU-S and percentage of CFU-S in S phase of the cell cycle provided further evidence that rIL-1 injection did not increase the number of CFU-S prior to irradiation. In a marrow-repopulation assay, cellularity as well as the number of erythroid colony-forming units, erythroid burst-forming units, and granulocyte-macrophage colony-forming cells per femur of lethally irradiated mice were not increased in recipient mice of donor cells from rIL-1 injected mice. These results demonstrated that a twofold increase in the number of CFU-S at the time of irradiation was not necessary for the earlier recovery of CFU-S observed in mice irradiated with sublethal doses of radiation 20 h after rIL-1 injection.

20447 (AD-A–214335/2/XAB) **L-leucyl-l-leucine methyl ester treatment of canine marrow and peripheral blood cells: Inhibition of proliferative responses with maintenance of the capacity for autologous marrow engraftment.** Raff, R.F.; Severns, E.; Storb, R.; Martin, P.; Graham, T. Armed Forces Radiobiology Research Inst., Bethesda, MD (USA). Nov 1988. 7p. (AFRRI-SR–89-36). Available from NTIS, PC A02/MF A01.

Pub. in Transplantation, Vol. 46, No. 5, 655-660(Nov 1988).

The success of allogeneic marrow transplantation as treatment for malignant and nonmalignant hematopoietic diseases has been restricted by the serious complications of graft-versus-host disease. Experiments in a variety of mammalian marrow transplant models have shown that removal of mature T cells from donor marrow permits engraftment without the development of GVHD. Incubation of canine marrow and peripheral blood mononuclear cells with L-leucyl-L-leucine methyl ester resulted in the inhibition of mitogen- and alloantigen induced blastogenesis, the elimination of allosensitized Cytotoxic T Lymphocyte and Natural Killer activity, and prevented the development of CTL from pCTL. The effects of these incubations were similar to those described in mice and humans. Additionally, in vitro CFU-GM growth from treated canine marrow was reduced, but could be regained when the Leu-Leu-OMe-treated marrow was cocultured with either untreated autologous peripheral blood mononuclear cells or monocyte-enriched PBMC but not with untreated monocyte-depleted PBMC. Six of seven dogs conditioned with 920 cGy total-body irradiation engrafted successfully after receiving autologous marrow that was incubated with Leu-Leu-OMe prior to infusion. These cumulative results indicate that incubation with Leu-Leu-OMe is a feasible method to deplete canine marrows of alloreactive and cytotoxic T cells prior to transplantation.

20448 (CONF-8911146–8) **The importance of the direct method of genetic risk estimation and ways to improve it.** Selby, P.B. Oak Ridge National Lab., TN (USA). [1989]. 19p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Banbury Center conference on mutation induction and heritability in mammalian germ cells; Cold Spring Harbor, NY (USA); 12-15 Nov 1989. Order Number DE90007125. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The direct method of genetic risk estimation provides a much more straightforward way of estimating first-generation genetic risk in humans than the doubling-dose method. Furthermore, committees involved in risk estimation have found that they cannot apply the doubling-dose method to estimate the risk from the large class of genetic disorders with complex etiology. With the direct method, data can be collected in such a way that serious mutations of all types are detected, including those with very low penetrance, which probably relate to many disorders with complex etiology. This goal can be met if the primary emphasis is given to identifying all first-generation offspring with clinically important phenotypes, in the body system being studied, and if the induced mutation frequency is calculated by subtracting the frequency of such offspring in the control group from that in the experimental group. The proposed assessment of dominant damage would provide the necessary information on skeletal damage for use in the direct method of genetic risk estimation as well as additional information for a more sensitive general test of the possible mutagenicity of the treatment. Because only a fraction of induced mutations cause clinically important effects in heterozygotes, it is essential, when estimating genetic risk, to know the health consequences of the mutations induced as well as the mutation frequency.

20449 (EGG-BNCT–8353-Vol.3-No.8) **PBF/BNCT Program for cancer treatment: Volume 3, No. 8: Bulletin, August 1989.** Ackermann, A.L. (ed.); Dorn, R.V. III. EG and G Idaho, Inc., Idaho Falls, ID (USA). Aug 1989. 54p. Sponsored by U.S. DOE Energy Research. DOE Contract AC07-76ID01570. Order Number DE90007043. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Highlights of the PBF/BNCT Program during August include progress within several areas. We studied gross boron analysis in tissue, blood, and urine (after resolving some technical problems, a method has been developed for digesting tissue samples as small as 0.05 gm); analytical methodologies development for BSH purity

determination (program participants met to finalize the transfer of the silica-based, microbore HPLC technology necessary for the BSH IND applications); boron microscopic (subcellular) analytical development (BSH uptake studies in U-87 human glioblastoma cells indicated that a six-hour exposure to 500 μg/mL resulted in a dramatic increase in nuclear concentration of boron, but with some evidence of cellular damage); noninvasive boron quantification determination (NMR and MRI studies of BSH binding with albumin and other tissues have shown large temperature effects on albumin binding which may impact analysis of various tumor-boron delivery mechanisms); and dosimetry (work is proceeding on BMRR Al_2Al_3 filter characterization with measurement of the fast-neutron spectrum).

20450 (EGG-BNCT–8353-Vol.3-No.9) **PBF/BNCT Program for cancer treatment: Volume 3, No. 9: Bulletin, September 1989.** Ackermann, A.L. (ed.); Dorn, R.V. III. EG and G Idaho, Inc., Idaho Falls, ID (USA). Sep 1989. 43p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90007044. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Highlights of the PBF/BNCT Program during August included: gross boron analysis in tissue, blood, and urine (biological samples for boron analysis were received from WSU, including samples from five p-BPA/melanoma dogs and seven BSH plasmapheresis dogs); analytical methodologies development for BSH (borocaptate sodium) purity determination (much effort this month focussed on the effort to develop a procedure for the separation of the optical isomeric forms of p-BPA for future application in melanoma BNCT); boron microscopic analytical development (analysis of SIMS images of boron-treated U-87 cells is complete and results will show cellular concentrations of B, K, Na, and Ca under different drug dosages); noninvasive boron quantification determination (optimization of pulse sequences for ^{10}BSH MRI may result from the dissolving of double quantum coherence differences between ^{10}BSH and ^{11}BSH); and additional measurements have greatly narrowed the previously observed differences between calculated and measured total radiation doses in phantoms.

20451 (EGG-BNCT–8353-Vol.3-No.10) **PBF/BNCT Program for cancer treatment: Volume 3, No. 10: Bulletin, October 1989.** Ackermann, A.L. (ed.); Dorn, R.V. III. EG and G Idaho, Inc., Idaho Falls, ID (USA). Oct 1989. 46p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90006954. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Highlights of the PBF/BNCT Program during October include progress in several areas. Included are Gross Boron Analysis in Tissue, Blood, and Urine (Large numbers of samples from Project 2 continue to be processed every month); Analytical Methodologies Development for BSH (Borocaptate Sodium) Purity Determination (Early results from evaluation of 30-cm Nucleosil C-18 columns indicate resistance to degradation by the mobile phase); Boron Microscopic Analytical Development (Analysis of data from boron-treated, U-87 human glioblastoma cells showed expected increased uptake with increased dosage); Noninvasive Boron Quantification Determination (Successful three-dimensional chemical shift imaging of boron in a canine pituitary-tumor patient has been carried out at EIRMC); and Dosimetry (Additional neutron spectrometry measurements using 2.6 atm. hydrogen, proton recoil chamber were taken at the BMRR to supplement foil activation measurements in an effort to more precisely identify overall characteristics of the fast-neutron contamination and streaming).

20452 (EGG-BNCT–8353-Vol.3-No.11) **PBF/BNCT Program for cancer treatment: Volume 3, No. 11: Bulletin, November 1989.** Ackermann, A.L. (ed.); Dorn, R.V. III. EG and G Idaho, Inc., Idaho Falls, ID (USA). Nov 1989. 35p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90006952. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Highlights of the PBF/BNCT Program during November include progress in several areas. Included are Gross Boron Analysis in Tissue, Blood, and Urine (All samples currently available from the dog studies have been prepared for analysis); Analytical Methodologies Development for BSH Purity Determination (Further investigations of the 2-mm microbore C18 column continued looking at higher carbon loading and its effect on column lifetime); Boron Microscopic Analytical Development (Six samples of canine oral melanoma were evaluated); Noninvasive Boron Quantification Determination (A new dog-head positioning device is under design to permit more precise alignment of boron concentrations); and Dosimetry (The weak BMRR neutron source strength has not allowed collimation of the filtered beam for the dog irradiations).

20453 (EGG-BNCT–8353-Vol.3-No.12) **PBF/BNCT [Power Burst Facility/Boron Neutron Capture Therapy] Program for Cancer Treatment bulletin: Volume 3, No. 12.** Ackermann, A.L. (ed.); Dorn, R.V. III. EG and G Idaho, Inc., Idaho Falls, ID (USA). Dec 1989. 37p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90006986. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Highlights of the PBF/BNCT Program during November include progress in several areas. Included are: Gross Boron Analysis in Tissue, Blood, and Urine (165 samples were analyzed during the month with 107 additional samples received); Analytical Methodologies Development for BSH Purity Determination (A Phenomonex HPLC column is currently being studied. This column has a higher carbon loading factor (30%) than other reverse-phase columns and allows a higher methanol:water ratio (57:43), which is apparently resulting in a significantly longer column lifetime without degradation); Noninvasive Boron Quantification Determination (A summary report documenting MR properties of BSH, progress to date, and future plans is in preparation); and Dosimetry (Analysis of the August and October 1989 BMRR neutron filter spectrum measurement in the 40-1200 keV energy range has been completed).

20454 (EGG-SARE–8769) **Radionuclide uptake in plants.** Harris, G.A. EG and G Idaho, Inc., Idaho Falls, ID (USA). Oct 1989. 35p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC07-76ID01570. Order Number DE90007290. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

As part of a preliminary evaluation of possible transport paths for radionuclides stored in a deep burial zone, the possibility of plant root penetration and subsequent uptake of the waste was considered. This report summarizes a literature review of plant uptake of the radionuclides ^{241}Am, ^{237}Np, ^{231}Pa, $^{238-242}$Pu, ^{226}Ra, $^{229-232}$Th, and ^{233,238}U. The purpose of the review is to determine if plants at the Nevada Test Site uptake radionuclides and if so, by how much. The report discusses studies dealing either specifically with the named radionuclides or more generally with the physics and chemistry of radionuclide uptake by plants. A summary of this information is given at the end of the report. 73 refs., 3 tabs.

20455 (GSF–7/87) **Role of ionising rays in the cerebral development of the NMRI mouse: Findings on the pathogenesis of hydromicrencephaly.** Heinzmann, U. Gesellschaft fuer Strahlen- und Umweltforschung m.b.H. Muenchen, Neuherberg (Germany, F.R.). Abt. fuer Nuklearbiologie; Technische Univ. Muenchen (Germany, F.R.). 1987. 185p. (In German). Order Number DE90753462. Available from NTIS (US Sales Only), PC A09/MF A01.

Discussed are experimental findings on the induction and pathogenesis of hydromicrencephaly in NMRI mice that were revealed after a single exposure to X-rays on day 12 of gestation using doses of 0.9 or 1.9 Gy. The sequence of the resultant ultrastructural changes in the ventricular walls was in the centre of the evaluation process, in which acute damage immediately after exposure was ascertained just as well as post-natal development disorders of the pups. (orig.).

20456 (HW–23140-E) **Radiological Sciences Department, report for month of December, 1951.** Parker, H.M. Hanford Works, Richland, WA (USA). 7 Jan 1952. 22p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC06-76RL01830. Order Number DE90007030. Available from NTIS, PC A03/MF A01 - OSTI.

Declassified 2 Feb 1990.

Two Class II and one Class I radiation hazards incident investigations were reported. One of these occurred to a Radiological Sciences Department employee while assisting another site. None involved exposure doomed to be of any consequence. There was

no finding in control or research activities worthy of special mention summary.

20457 (IAEA-TECDOC–527, pp. 199-201) **The role of sulphur compounds in affecting radiation response: Molecular aspects.** Tamba, M. (Istituto di Fotochimica e Radiazioni d'Alta Energia (CNR), Bologna (Italy)). International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8811309–: Advisory group on the assessment of new developments and trends in radiation chemistry, Bologna (Italy), 14-17 Nov 1988). In *New trends and developments in radiation chemistry: Proceedings of an advisory group meeting held in Bologna, Italy, 14-17 November 1988.* Order Number DE90617335. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

Published in summary form only. 4 refs. GLUTATHIONE/biological radiation effects; THIOLS/biological radiation effects; BIOCHEMICAL REACTION KINETICS; BIOLOGICAL REPAIR; GLUTATHIONE; RADIOPROTECTIVE SUBSTANCES; THIOLS; THIYL RADICALS

20458 (INP–1335/B) **Somatic mutations in Tradescantia as a model system for studying the effects of the environmental agents.** Cebulska-Wasilewska, A. Institute of Nuclear Physics, Cracow (Poland). 1986. 107p. (In Polish). Order Number DE90617556. Available from NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS.

The application of the plant model system for studying the biological effects of ionizing radiation and chemical mutagens is presented. The model system is based on the somatic mutation frequency in stamen hair cells of Tradescantia clones heterosygous for flower color. The interaction of chemical mutagens with radiation in the induction of somatic mutations was investigated. The results demonstrate the synergistic interaction between radiation and chemical mutagens like ethyl methanesulfonate and dibromoethane. The synergistic effect is clearly manifested after combined treatment with radiation and chemicals. In the low dose region the effect depends on the radiation dose and chemical exposure. Other results show the influence of the fluoride treatment on the radiation effect. The fluoride treatment is likely to alter the DNA double strand breaks repair processes. Additionally the usefulness of the model system for studying the mutagenic effectiveness of the pollution in the ambient air is presented. 148 refs. (author).

20459 (INP–1346/PL) **The influence of low doses of ionizing radiation on biological systems.** Kwiecinska, T. (Wyzsza Szkola Pedagogiczna, Cracow (Poland)). Institute of Nuclear Physics, Cracow (Poland). Nov 1986. 23p. Order Number DE90617557. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Recent results concerning possible beneficial effects of low doses of ionizing radiation on biological systems are summarized. It is also pointed out on the basis of existing evidence that harmful effects on living organisms take place not only in the case of excess but also in the case of deficiency of ionizing radiation. Possibility of using radio-enhanced ultralow luminescence for studying hormesis phenomena is discussed. 24 refs., 4 figs. (author).

20460 (IPEN-PUB–276) **Notions of radiation chemistry in biological systems.** Mastro, N.L. del. Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo, SP (Brazil). Oct 1989. 20p. (In Portuguese). Order Number DE90617548. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The present paper examines some aspects of the direct and indirect biological radiation effects: pair formation, free radicals, superoxide ion, hydrogen peroxide, hydroxyl radical, oxygen singlet together with the endogen radioprotector mechanisms of organisms and the ways in which an improved radioresistance of biochemical systems can be achieved. (author).

20461 (KURRI-TR–320, pp. 18-27) **Studies on radiation-induced thymic lymphomagenesis in B10 strain mice: Development and phenotypic characterization of thymic prelymphoma cells.** . Muto, Masahiro (National Inst. of Radiological Sciences, Chiba (Japan)). Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst. Jul 1989. (In Japanese). (CONF-8901175–: Symposium on radiation research in life science, Kumatori (Japan), 13-14 Jan 1989). In *Proceedings of the symposium on 'radiation research in life science': Radiation and oncogenesis.* Order Number DE90741371. Available from NTIS (US Sales Only), PC A03/MF A01.

Using B10.Thy 1 congenic strain mice, we reexamined the earlier results by Kaplan et. al. that lymphomas could develop from lymphocytes present in the nonirradiated parental thymuses grafted into thymectomized, fractionally irradiated H-2 semiincompatible recipient mice. The results indicated that 37 out of 91 thymectomized and irradiated B10.Thy 1.2 mice developed lymphomas of which 75 % were shown to have originated from grafted thymuses. Evidence was not obtained to support the involvement of endogenous MuLV or some kind of transmissible agents during thymic lymphomagenesis. We found, with intrathymic injection assay, that preneoplastic cells that will eventually develop into thymic lymphomas under the influence of thymic microenvironment first appeared in the thymuses about 4-8 days after irradiation. These thymic prelymphoma cells thymus-dependent preneoplastic cells were detected in 26.1% of the test donor thymuses when examined at 14 days and in more than 63% 21 and 31 days after irradiation. It was found that lymphomagenic irradiation resulted in the anomalous appearance of $CD4^+$ and/or $CD8^+$ thymocytes bearing IL-2 receptor (IL-2R) which were different from normal thymocyte subpopulations. Thymic prelymphoma cells existed mainly in $CD4^-$ $CD8^-$ and $CD4^-$ $CD8^+$ thymocyte subpopulations and also in $CD4^+$ $CD8^+$ subpopulation. T cell lymphomas derived from $CD4^-$ $CD8^-$ prelymphoma cells had mainly $CD4^-$ $CD8^-$ or $CD4^-$ $CD8^+$ phenotypes. T cell lymphomas developed from $CD4^-$ $CD8^+$ prelymphoma cells mainly expressed $CD4^-$ $CD8^+$ or $CD4^+$ $CD8^+$ phenotype. T cell lymphomas originated from $CD4^+$ $CD8^+$ prelymphoma cells were mainly $CD4^+$ $CD8^+$ but some $CD4^-$ $CD8^+$ or $CD4^+$ $CD8^-$ cells were also present. These T cell lymphomas expressed IL-2R on various levels.

20462 (LBL–28252) **Clinical results of stereotactic heavy-charged-particles radiosurgery for intracranial arteriovenous malformations.** Fabrikant, J.I.; Levy, R.P.; Frankel, K.A.; Phillips, M.H.; Lyman, J.T.; Steinberg, G.K.; DeLaPaz, R.L.; Marks, M.P.; Chuang, F.Y.S. Lawrence Berkeley Lab., CA (USA). Dec 1989. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-8905227–4: International conference on radiosurgery a neurosurgical approach to intracranial lesions, Charlottesville, VA (USA), 1-5 May 1989). Order Number DE90007061. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

At Lawrence Berkeley Laboratory, we have developed the method of stereotactic heavy-charged-particle (helium-ion) Bragg peak radiosurgery for treatment of surgically-inaccessible intracranial arteriovenous malformations (AVMs). This report describes patient selection, treatment method, clinical and neuroradiologic results and complications encountered in 322 patients since 1980. 7 refs., 3 figs.

20463 (NUREG/CR–5512) **Residual radioactive contamination from decommissioning: Technical basis for translating contamination levels to annual dose: Draft report for comment.** Kennedy, W.E. Jr. (Pacific Northwest Lab., Richland, WA (USA)); Peloquin, R.A. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Regulatory Applications; Pacific Northwest Lab., Richland, WA (USA). Jan 1990. 313p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC06-76RL01830. (PNL–7212). Available from NTIS, PC A14/MF A01 - GPO; OSTI; INIS.

This document describes the generic modeling of the total effective dose equivalent (TEDE) to an individual in a population from a unit concentration of residual radioactive contamination. Radioactive contamination inside buildings and soil contamination are considered. Unit concentration TEDE factors by radionuclide, exposure pathway, and exposure scenario are calculated. Reference radiation exposure scenarios are used to derive unit concentration TEDE factors for about 200 individual radionuclides and parent-daughter mixtures. For buildings, these unit concentration factors list the annual TEDE for volume and surface contamination situations. For soil, annual TEDE factors are presented for unit concentrations of radionuclides in soil during residential use of contaminated land and the TEDE per unit total inventory for potential use of drinking water from a ground-water source. Because of the generic treatment of potentially complex ground-water systems, the

annual TEDE factors for drinking water for a given inventory may only indicate when additional site data or modeling sophistication are warranted. Descriptions are provided of the models, exposure pathways, exposure scenarios, parameter values, and assumptions used. An analysis of the potential annual TEDE resulting from reference mixtures of residual radionuclides is provided to demonstrate application of the TEDE factors. 62 refs., 5 figs., 66 tabs.

20464 (NUREG/CR–5516) **Causes of failing the draft ANSI Standard N13.30 radiobioassay performance criterion for minimum detectable amount.** MacLellan, J.A. Pacific Northwest Lab., Richland, WA (USA). Feb 1990. 43p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC06-76RL01830. (PNL–7217). Available from NTIS, PC A03/MF A01 - GPO; OSTI; INIS.

The test methods used for PNL bioassay performance tests were evaluated by comparing the MDA based on performance tests results with MDA calculated by PNL using the bioassay laboratory's own quality control (QC) data. Two in vitro laboratories and two in vivo laboratories were studied and a correlation between the performance test MDA estimates and QC data was demonstrated. However, it was often necessary to examine the QC data to identify important characteristics of the blank distribution that affect the MDA calculation. Since the MDA equation must be based on the specific analysis and calculational methods of the procedure evaluated. Even when the correct MDA equation is applied, the MDA calculated will have a relatively large confidence interval when only a few replicates are used to estimate the standard deviation. For this reason, a relatively precise estimate of the MDA is generally only available when Poisson statistics may be applied. It was concluded that performance testing alone cannot provide all the information necessary to make an accurate estimate of the measurement process MDA. Review of the laboratory's QC data and the entire measurement procedure will be necessary. Specific recommendations for changes to draft ANSI N13.30 "Performance Criteria for Radiobioassay" are given. 10 refs., 18 figs., 11 tabs.

20465 (OEFZS–4506) **Indications of an adaptive response in C57bl mice pre-exposed in vivo to low doses of ionizing radiation.** Wojcik, A.; Tuschl, H. Oesterreichisches Forschungszentrum Seibersdorf G.m.b.H. (Austria). Inst. fuer Biologie. Aug 1989. 16p. (BL–851/89). Order Number DE90617558. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

C57bl/6 mice were whole body irradiated with 50 mGy/day ('adapting dose') on four consecutive days and their spleens removed on the 1st, 3rd, 7th, 12th, 19th, and 26th day after the last irradiation. In vitro UV-light-induced UDS and MMC-induced SCEs were scored in lymphocytes, UV-light and MMC being the 'challenging agents' yielding higher UDS values and lower frequencies of induced SCEs than in cells of nonadapted animals. On day 12 this effect could only be seen in half, on day 19 and 26 in none of the performed experiments. The results support those published by Tuschl and Liu in showing that it is possible to induce the adaptive response in vivo. 1 fig., 4 tabs., 26 refs. (Authors).

20466 (UCID–21824-Rev.1) **Bounding dispersion analysis for rare-earth elements as it pertains to the Engineering Demonstration System surrogate testing: Revision 1.** Ernst, K. Lawrence Livermore National Lab., CA (USA). Jan 1990. 14p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90006337. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

An analysis of a bounding atmospheric dispersion of a rare-earth oxide shows that the off-site concentrations are significantly less than established health guidelines and ground deposition will not result in an impact to the food chain. For these reasons, we conclude that the use of rare-earth elements in the Engineering Demonstration System (EDS) will have no health impact to the public due to atmospheric dispersion. 8 refs., 1 fig., 3 tabs.

20467 Rhizobium meliloti mutants that overproduce the R. meliloti acidic Calcofluor-binding exopolysaccharide. Doherty, D. (Massachusetts Institute of Technology, Cambridge (USA)); Glazebrook, J.; Walker, G.C.; Leigh, J.A. *Journal of Bacteriology (USA)*, 170(9): 4249-4256 (Sep 1988). DOE Contract FG06-86ER13532.

The acidic Calcofluor-binding exopolysaccharide of Rhizobium meliloti Rm1021 plays one or more critical roles in nodule invasion and possible in nodule development. Two loci, exoR and exoS, that effect the regulation of synthesis of this exopolysaccharide were identified by screening for derivatives of strain Rm1021 that formed mucoid colonies that fluoresced extremely brightly under UV light when grown on medium containing Calcofluor. The exopolysaccharide produced in large quantities by the exoR95::Tn5 and exoS96::Tn5 strains was indistinguishable from that produced by the parental strain Rm1021, and its synthesis required the function of at least the exoA, exoB, and exoF genes. Both the exoR and exoS loci were located on the chromosome, and the exo96::Tn5 mutation was 84% linked to the trp-33 mutation by ΦM12 transduction. Synthesis of the Calcofluor-binding exopolysaccharide by strain Rm1021 was greatly stimulated by starvation for ammonia. In contrast, the exoR95::Tn5 mutant produced high levels of exopolysaccharide regardless of the presence or absence of ammonia in the medium. The exoS96::Tn5 mutant produced elevated amounts of exopolysaccharide in the presence of ammonia, but higher amounts were observed after starvation for ammonia. The presence of either mutation increased the level of expression of exoF::TnphoA and exoP::TnphoA fusions. Analyses of results obtained when alfalfa seedlings were inoculated with the exoR95::Tn5 strain indicated that the mutant strain could not invade nodules. However, pseudorevertants that retained the original exoR95::Tn5 mutant but acquired unlinked suppressors so that they produced an approximately normal amount of exopolysaccharide were able to invade nodules and fix nitrogen.

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Refer also to citation(s) 19772, 19773, 19947, 20287, 20288, 20350, 20389, 20395, 20404, 20405, 20406

20468 (AD-A–214201/6/XAB) **Mutagenic responses of some petroleum-base obscurants in the Ames test. Technical report, October 1986-December 1987.** Lee, F.K.; Muse, W.T.; Brown, B.J. Chemical Research, Development and Engineering Center, Aberdeen Proving Ground, MD (USA). Sep 1989. 21p. (CRDEC-TR–071). Available from NTIS, PC A03/MF A01.

In the Ames test, five petroleum fractions diesel fuel (DF) 25% distilled, DF with approximately 6% tetraethoxysilane, Jet-A, 75% bottoms product and Fog Oil, and methylene chloride extractions of combusted DF were evaluated for their mutagenic potential. The five fractions were dissolved in ethanol containing 1% Tween 80. One hundred milligrams of the residue from combusted DF was extracted with 25 mL of methylene chloride for 24 hr. After that time, the methylene chloride was replaced with acetone by evaporation. Each of five materials was tested in the four standard tester strains; TA97, TA98, TA100, and TA102, metabolically activated (aroclor 1254 induced rat liver S9) and nonactivated. Five concentrations, ranging upwards to the approximate level of cytotoxicity, of each material were tested, and the results in each case were confirmed with a similar nonconcurrent test. Positive results were not demonstrated in any of the materials tested.

20469 (KFK–4624) **Cytotoxic effects of quartz and asbestos: Interspecies comparison of alveolar macrophages in vitro.** Schimmelpfeng, J. Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Genetik und Toxikologie von Spaltstoffen; Karlsruhe Univ. (T.H.) (Germany, F.R.). Fakultaet fuer Bio- und Geowissenschaften. Oct 1989. 154p. (In German). Order Number DE90753306. Available from NTIS (US Sales Only), PC A08/MF A01.

Cytotoxic effects of quartz and chrysotile asbestos on alveolar macrophages of different species were compared in vitro. The type of cell reaction towards the toxic dusts was always the same: A loss of viability was accompanied by the release of cytoplasmic and lysosomal enzymes. In addition, morphological changes were visible. The extent of cellular destruction depended on the applicated dust concentration. In comparison with the results from other groups it could be concluded, that the amount of cell damage correlated with the surface cover of the culture vessel with dust. In the range of 50-100 μg quartz or chrysotile asbestos/ml species specific variations in the sensitivity of the cells were observed. At this

concentration alveolar macrophages from dog, monkey and man were destroyed to a greater extent than the cells from rat and cattle. Simultaneous incubation of the cells with dipalmitoyl-lecithin and quartz (250 μg/ml) resulted in a reduction of the cytotoxic effect of quartz. The extent of this protective effect varied according to the species. In the case of chrysotile asbestos, no reduction in the toxicity of the fibres was observed in the presence of dipalmitoyl-lecithin. (orig.).

20470 (PB–90-125873/XAB) **Comparison of robust Bayes and classical estimators for regional lake models of fish response to acidification.** Reckhow, K.H. Duke Univ., Durham, NC (USA). School of Forestry and Environmental Studies. c 1988. 10p. Available from NTIS, PC A02/MF A01.

Pub. in Water Resources Research, Vol. 24, No. 7, 1061-1068(Jul 1988).

Empirical models of fish response to lake acidification were recently fit to a large historical data set from the Adirondack region of the United States using classical and Bayesian methods. The models may be used to predict species presence/absence for brook trout and lake trout as a function of acid-precipitation-related water chemistry, using a logistic function. To evaluate the effectiveness of the models in the prediction of presence/absence due to regional lake acidification, new data sets were used for cross validation of the candidate models. Based on the evaluation, the robust Bayes models, which are based on a compromise estimator between Bayes and empirical Bayes, were found to be the best predictors of species presence/absence in lakes.

20471 (PB–90-126046/XAB) **Toxicological methods for determining the effects of contaminated sediment on marine organisms.** Swartz, R.C. Environmental Protection Agency, Narragansett, RI (USA). Environmental Research Lab. c 1984. 11p. (ERLN-N–056). Available from NTIS, PC A03/MF A01.

Pub. in Fate and Effects of Sediment-Bound Chemicals in Aquatic Systems, p183-198(1984).

Most chemicals and waste materials discharged into the marine environment contain fractions that eventually accumulate in sediment. Uncertainty about the ecological significance of sediment contamination to benthic, epibenthic, and pelagic communities has prompted development of methods for testing sediment toxicity. The Environmental Protection Agency (EPA)/Army Corps of Engineers (USACE) Implementation Manual (1), mandated by the 1977 Ocean Dumping Regulations, provided the first guidance for sediment bioassays. During the next 7 years, a great variety of ecotoxicological methods were used to evaluate sediment contamination. The paper reviews these methods and evaluates their application in regulatory, monitoring, and research programs.

20472 (PB–90-127978/XAB) **Comparative analysis of polychlorinated dibenzo-'p'-dioxin and dibenzofuran congeners in Great Lakes fish extracts by gas chromatography-mass spectrometry and in-vitro enzyme induction activities.** Zacharewski, T.; Safe, L.; Safe, S.; Chittim, B.; DeVault, D. Environmental Protection Agency, Duluth, MN (USA). Environmental Research Lab. c 1989. 8p. Available from NTIS, PC A02/MF A01.

Pub. in Environmental Science and Technology, Vol. 23, No. 6, 730-735(1989).

The high-resolution gas chromatographic-mass spectrometric analysis of 25 Great Lakes fish extracts confirmed the identities of several 2,3,7,8-tetrasubstituted polychlorinated dibenzofurans (PCDFs) and dibenzo-p-dioxins (PCDDs). The dominant congener in extracts from Lake Michigan, Lake Erie, Lake St. Clair, Lake Huron, and Lake Superior fish was 2,3,7,8-tetrachlorodibenzofuran (TCDF). The fish extracts from Lake Ontario showed significant levels of 2,3,7,8-tetrachlorobenzo-p-dioxin (TCDD) besides containing considerable amounts of PCDFs. The 2,3,7,8-TCDD equivalents in these extracts were determined by their activities as inducers of aryl hydrocarbon hydroxylase (AHH) and ethoxyresorufin O-deethylase (EROD) in rat hepatoma H-4-II E cells in culture. For most of these samples, there was less than a 2-fold difference in the bioassay-estimated 2,3,7,8-TCDD equivalents and the total PCDDs plus PCDFs as determined by GC-MS. The bioassay-derived values were significantly (>2-fold) higher for the Lake Erie and Lake Ontario fish extracts. This difference may be due to several factors including synergistic interactive effects of the congeners in the bioassay induction response or the presence of bioassay-active components that are not detected by GC-MS analysis.

20473 (PB–90-128000/XAB) **Toward a quantitative comparative toxicology of organic compounds.** Hansch, C.; Kim, D.; Leo, A.J.; Novellino, E.; Silipo, C. Pomona Coll., Claremont, CA (USA). 1989. 44p. Available from NTIS, PC A03/MF A01.

Pub. in CRC Critical Reviews in Toxicology, Vol. 19, No. 3, 185-226(1989).

There are more than 70,000 man-made chemicals in widespread usage in our world today, with additions coming along at a clip of more than 5,000 per year. Besides these, hundreds of thousands of new structures are synthesized each year in many academic and industrial laboratories. Toxicological problems that may be associated with the latter must be ignored, at least until some serious accident forces them onto us or until they move into the marketplace. It is impossible to test all of these chemicals in all of the tests that have been devised and are continuing to appear. To make matters more confusing, there is no generally accepted way to collect and organize the streams of data from all kinds of tests on all kinds of compounds that flow from many laboratories. With governments and industrial laboratories planning to spend billions in the coming decades, it is urgent that more systematic means for the organization and discussion of these results be developed. It is viewed that a long-term objective of toxicology must be to devise a computerized data base of numerically defined, statistically validated, structure-activity relationships.

20474 (PB–90-129271/XAB) **Effects of toxic substances on zooplankton populations: a Great Lakes perspective.** Evans, M.S.; McNaught, D. Michigan Univ., Ann Arbor, MI (USA). Great Lakes Research Div. c 1988. 27p. (CONTRIB–472). Available from NTIS, PC A03/MF A01.

Pub. in Toxic Contaminants and Ecosystem Health; A Great Lakes Focus, Chapter 3, 53-76(1988).

The chapter discusses how toxic substances can affect zooplankton, both at the species and community level, modifying factors affecting toxicity, the effects of various environmental pertubations, including toxic substances, on Great Lakes zooplankton, and the role of zooplankton in the transport, persistence, and biomagnification of toxic substances.

20475 (PB–90-129396/XAB) **Asbestos dust: A study on the pathogenetic mechanism. Technical report (Final).** Gross, P.; Harley, R.A. Industrial Health Foundation, Inc., Pittsburgh, PA (USA). 12 Dec 1972. 22p. Available from NTIS, PC A03/MF A01.

Samples of crocidolite, amosite, and Canadian chrysotile were prepared by five different methods for intratracheal injection to rats. A fairly high mortality was noted in the first 6 months, generally from pneumonia. Of the 1537 rats injected intratracheally one to four times, only 727 rats survived 6 months. The total dosage ranged from 1.75 to 21 milligrams. The results of the study indicated that the intratracheal injection of the three most important asbestos dusts into rats caused no induction of cancer. It made no difference to the outcome whether these dusts were natural or had been modified by the addition or subtraction of trace metals, or whether the dusts had been heated. A significant lessening of the fibrogenicity of asbestos dust was caused by heating the dusts. These findings suggested that the theory that trace metals assist in the pathogenic potential of asbestos dust must be abandoned. The failure of lung cancers to develop in the study as they had in previous studies could not be explained. The report concluded that the pathogenicity of chrysotile asbestos may not be attributable to its fibrous shaped particles, its magnesium-silicate molecule, or to its crystalline character.

20476 (PB–90-129412/XAB) **Vanadium toxicity: A study of mechanisms.** Klevay, L.M. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). 13 Feb 1973. 5p. Available from NTIS, PC A01/MF A01.

The purpose of the investigation was to produce marginal chromium deficiencies in rats through manipulation of their diets. After this deficiency was produced, small amounts of vanadium compounds were added to the drinking water of the animals and the effects of this addition were studied. One group of rats were fed a diet deficient in chromium with 5 micrograms of chromium/milliliter

drinking water. No increase was noted in the glucose metabolism on this diet. A second group received 10 micrograms chromium/milliliter drinking water. No differences were noted between the group supplemented with chromium and the control group, or the group supplemented with vanadium at 5 micrograms vanadium/milliliter water and the control group or the groups supplemented with chromium and vanadium, concerning measurements of cholesterol in plasma. The findings were at variance with other published reports and indicated that only under certain circumstances did exposure to vanadium and chromium cause changes in the metabolism of cholesterol. It suggests that the experimental approach is probably not appropriate for the study of vanadium intoxication in industrial settings. However, the approach may be useful in studies on the pathogenesis of atherosclerotic heart disease.

20477 (PB–90-129511/XAB) **Environmental significance of the potential for mer (Tn21)-mediated reduction of Hg (2+) to Hg in natural waters.** Barkay, T.; Liebert, C.; Gillman, M. Technical Resources, Inc., Gulf Breeze, FL (USA). c 1989. 9p. Available from NTIS, PC A02/MF A01.

Pub. in Applied and Environmental Microbiology, Vol. 55, No. 5, 1196-1202(May 1989).

The role of mer(Tn21) in adaptation of aquatic microbial communities to Hg2+ was investigated. Elemental mercury was the sole product of Hg2+ volatilization by freshwater and saline microbial communities. Bacterial activity was responsible for biotransformation because most microeukaryotes did not survive the exposure conditions, and removal of larger microbes (> 1 microgram) from adapted communities did not significantly ($P > 0.01$) reduce Hg2+ volatilization rates. DNA sequences homologous to mer(Tn21) were found in 50% of Hg2+ resistant bacterial strains representing two freshwater communities, but in only 12% of strains representing two saline communities (difference highly significant, $P < 0.001$). Thus, mer(Tn21) played a significant role in Hg2+ resistance among strains isolated from freshwaters where microbial activity had a limited role in Hg2+ volatilization. In saline environments where microbially mediated volatilization was the major mechanism of Hg2+ loss, other bacterial genes coded for the biotransformation.

20478 (PB–90-129842/XAB) **Subcellular distribution of cadmium within the lung and kidney after cadmium oxide inhalation exposure.** Blackstone, M.; Kaplan, P.; Richdale, N. Cincinnati Univ., OH (USA). Kettering Lab. 1989. 19p. Available from NTIS, PC A03/MF A01.

Male Sprague-Dawley-rats were exposed for 5 or 7 weeks to cadmium oxide aerosols at relatively low levels of 35 to 275 micrograms/cubic meter and sacrificed at 4 to 8 months of age. Cadmium was concentrated by the kidney and lung tissues in the cytoplasmic soluble fraction and in the connective tissue. Of the total cadmium present, 50 and 70% was associated with the kidney and lung supernatants, respectively. Even so, the total amount of the cadmium retained was far less than reported in the literature. Using an approximate lung volume of 2 cubic centimeters and a breathing rate of 80 times per minute, the percent retention in the lung was about 0.03% and in the kidney, about 0.003%. These low values may indicate an efficient clearance mechanism by the body which can be supported by the finding of virtually no cadmium present in the lung washings and very few particles present in the cell bodies or alveolar ducts on microscopic examination. However, after 6 weeks exposure, a slight amount of perivascular lymphoid hyperplasia was observed.

20479 (PB–90-129883/XAB) **Carbon monoxide and human functions.** Beard, R.R.; Grandstaff, N.W. Stanford Univ., CA (USA). Dept. of Community and Preventive Medicine. 6 Jul 1972. 37p. Available from NTIS, PC A03/MF A01.

The effects of low concentrations of carbon monoxide (CO) on several aspects of cerebral functions in man were examined. These functions included perception, discrimination, memory, and complex cognitive processes. The study participants included healthy young male and female Stanford students between ages 18 and 25 years. Each subject was exposed to CO in a chamber from which the air was continuously sampled. CO concentrations were 50, 175, or 250 parts per million. Each daily test session consisted of four rounds of 40 minutes each, divided into a 25- or 20-minute test period and a 15- or 20-minute rest period. Vigilance was significantly reduced and the performance of a given task involving estimation of time and motion together was also compromised. Only marginal impairment was noted in a complex problem-solving test. No consistency or reliability was discerned in the effects on spatial perception, digit span, or arithmetic performances.

20480 (PB–90-854423/XAB) **Dioxins: Formation, transport, and deterioration. June 1973-November 1989 (Citations from the NTIS data base). Report for June 1973-November 1989.** National Technical Information Service, Springfield, VA (USA). Dec 1989. 203p. Available from NTISPC N01/MF N01.

Supersedes PB–88-870563.

This bibliography contains citations concerning the formation, environmental transport, and degradation of dioxins. Formation by combustion is examined. Dioxin emission monitoring studies of municipal and industrial boilers are included. Dioxin level monitoring in humans, air, soil, and water is discussed. Methods of dioxin destruction discussed include controlled combustion and ultraviolet radiation. (This updated bibliography contains 353 citations, 83 of which are new entries to the previous edition.)

20481 Interactive effects of CO_2 and environment on net photosynthesis of water-lily. Allen, S.G. (U.S. Water Conservation Lab., Phoenix, AZ, (USA)); Idso, S.B.; Kimball, B.A. *Agriculture, Ecosystems and Environment (Netherlands),* 30(1-2): 81-88 (Jan 1990).

Water-lily (Nymphaea marliac) plants were grown out of doors in 570-l stock tanks contained in plastic-walled, open-topped CO_2-enrichment chambers continuously supplied with either 640 or 340 (ambient) microlitre CO_2 l^{-1} of air. Net photosynthesis (P_n) of water-lily leaves in each CO_2 treatment was measured hourly between 0800 and 1600 h MST on 26 October and 10 and 24 November 1987. Air temperature and net solar radiation were measured at the same time. The 3 days on which P_n was measured provided an air temperature range of 10.3-33.2 C and a net solar radiation range of 30-659 W m^{-2}. Significant linear relationships were established between P_n and air temperature and P_n and net solar radiation for both CO_2 treatments. Significant interactive effects of CO_2 and air temperature and CO_2 and net solar radiation were also found to affect P_n. In conditions generally unfavorable for P_n (low light and low temperature), there was no difference in P_n rate between the two CO_2 treatments. In conditions that were favorable for P_n (high light and high temperature), however, P_n in the 640 microlitre CO_2 l^{-1} of air treatment was as much as 60% greater than in the ambient CO_2 treatment. 4 figs., 14 refs.

20482 Biological markers in environmental species. McCarthy, J.F. (Oak Ridge National Lab., TN (USA)). *Preprints of Papers Presented at National Meeting, Division of Water, Air and Waste Chemistry, American Chemical Society (USA),* 28(2): 231-232 (Sep 1988). DOE Contract AC05-84OR21400. (CONF-8909236–: JAERI/EPA workshop on residual radiation and recycle criteria, St. Michaels, MD (USA), 27-28 Sep 1989).

Human exposure to environmental pollutants is often exceedingly complex. Sources of exposure are multiple, and the importance of a particular source may depend on individual practices. Humans are highly mobile, and direct study, particularly when physiological testing is required, is generally expensive and logistically difficult. For these reasons, a simpler animal model which provides a parallel biological marker in humans would be useful. Small mammals have frequently been used to monitor the presence of metals and other contaminants in the environment. Such biomonitoring can be essential for determining bioavailability and resultant biological effects under natural conditions. Small mammals can be particularly effect biomonitors of soil contaminants if the species used are abundant, easily caught, do not migrate long distances, and have well documented food habits. Good biomonitors are in equilibrium with the environment and should show a graded response to a range of pollutants. Their approach to detecting exposure to hazardous chemicals in the environment, and to estimating the potential for subsequent adverse effects, is to monitor biological endpoints in wild animals.

20483 Biological monitoring using cellular macromolecules. Shugart, L.R. (Oak Ridge National Lab., TN (USA)). *Preprints of*

Papers Presented at National Meeting, Division of Water, Air and Waste Chemistry, American Chemical Society (USA), 28(2): 288 (Sep 1988). DOE Contract AC05-84OR21400. (CONF-8909236--: JAERI/EPA workshop on residual radiation and recycle criteria, St. Michaels, MD (USA), 27-28 Sep 1989).

DNA damage has been proposed as a useful biological marker for assessing the genotoxic properties of environmental pollutants. Many of these pollutants are chemical carcinogens and mutagens with the capacity to cause various types of DNA damage. Genotoxic chemicals may form stable adducts with DNA, adducts which result in the formation of alkali-labile apurinic sites, and unstable adducts which cause strand breaks. Additional damage may occur through the inhibition of normal DNA repair. Each type of damage may contribute toward the eventual transformation of the cell. Analytical techniques that measure DNA damage have been developed at the Oak Ridge National Laboratory and have been used to assess the status of DNA in organisms exposed to chemical carcinogens under controlled laboratory conditions, and to fish and marine mammals from polluted and non-polluted environments. Preliminary data indicate the feasibility of monitoring DNA damage in an organism as a biological marker of environmental genotoxicity.

20484 Effects of silicon deficiency on lipid composition and metabolism in the diatom Cyclotella cryptica. Roessler, P.G. (Solar Energy Research Institute, Golden, CO (USA)). *Journal of Phycology (USA),* 24(3): 394-400 (Sep 1988).

The effects of silicon deficiency on the metabolism and composition of lipids in Cyclotella cryptica T13L Reimann, Lewin, and Guillard were examined Silicon-deficient cells had higher levels of neutral lipids (primarily triacylglycerols) and higher proportions of saturated and monounsaturated fatty acids than silicon-replete cells. After 4 h of silicon deficiency, the percentage of newly assimilated $NaH^{14}CO_3$ partitioned into lipids increased from 27.6% to 54.1%, whereas the percentage partitioned into chrysolaminarin decreased from 21.6% to 54.1%, whereas the percentage partitioned into chrysolaminarin decreased from 21.6% to 10.6%. In addition, pulse-chase experiments with $NaH^{14}CO_3$ indicated that the amount of ^{14}C in the total cellular lipid fraction increased by 32% after 12 h of silicon deficiency despite the absence of additional photoassimilable ^{14}C. Therefore, the accumulation of lipids in response to silicon deficiency appears to be due to two distinct processes: (1) an increase in the proportion of newly assimilated carbon partitioned into lipids, and (2) a slow conversion of previously assimilated carbon from non-lipid compounds into lipids.

20485 Site-directed mutation of the Escherichia coli ada gene: Effects of substitution of methyl acceptor cysteine-321 by histidine in Ada protein. Tano, K. (Univ. of Tennessee Graduate, Oak Ridge (USA)); Bhattacharyya, D.; Foote, R.S.; Mural, R.J.; Mitra, S. *Journal of Bacteriology (USA),* 41(3): 1535-1543 (Mar 1989). DOE Contract AC05-84OR21400.

Oligodeoxynucleotide-mediated mutagenesis of the ada gene of Escherichia coli was used to produce two mutant Ada proteins. In mutant I the methyl acceptor Cys-321 for O^6 -methylguanine was replaced by histidine; and in mutant II the positions of Cys-321 and His-322 of the wild-type protein were inverted. Neither mutant protein had O^6-methylguanine-DNA methyltransferase activity, but both retained the phosphotriester-DNA methyltransferase activity involving methyl group transfer to Cys-69. Under the control of the endogenous promoter, synthesis of mutant I protein was undetectable before of after adaptation treatment with N-methyl-N′-nitro-N-nitrosoguanidine. This appeared to be due to both inhibition of transcription of the mutant gene and degradation of the synthesized protein. On the other hand, mutant II protein was inducible by N-methyl-N′-nitro-N-nitrosoguanidine, although to a smaller extent than the wild-type protein was, and the phosphotriester-DNA methyltransferase activity appeared to reside in 24- to 30-kilodalton cleavage products. Mutant I protein could be produced under lac promoter control, and its cleavage products, unlike those of mutant II protein, tended to aggregate. These result indicate that (i) Cys-321 cannot be replaced or transposed with the nucleophilic amino acid histidine for O^6-methylguanine-DNA methyltransferase function, (ii) single amino acid replacement or transposition at the O^6-methylguanine methyl acceptor site can have a profound effect on the in vivo stability and regulatory function of the Ada protein, and (iii) the integrity of the protein may not be absolutely needed for its transcription-activation function.

20486 Tumorigenic methylcholanthrene transformants of C3H/10T$\frac{1}{2}$ cells have a common nucleotide alteration in the c-Ki-ras gene. Chen, A.C. (Univ. of California, Los Angeles (USA)); Herschman, H.R. *Proceedings of the National Academy of Sciences of the United States of America (USA),* 86(5): 1608-1611 (Mar 1989).

The polymerase chain reaction was used to amplify DNA surrounding the codon 12 region of the c-Ki-ras gene from C3H/10T$\frac{1}{2}$ cells and from a number of 3-methylcholanthrene (MCA)-transformed derivatives of these cells. Sequence analysis demonstrated that tumorigenic MCACl16/39 cells, known by DNA-mediated transfection to contain an activated c-Ki-ras oncogene, had a G → T transversion in the first position of codon 12 of this gene, resulting in a Gly^{12} → Cys mutation. A combination of polymerase chain-reaction amplification and oligonucleotide hybridization demonstrated that three additional tumorigenic MCA transformants of C3H/10T$\frac{1}{2}$ cells had an identical mutation in the c-Ki-ras gene. In contrast, this mutation was not present in an MCA-induced C3H/10T$\frac{1}{2}$ transformant that was not tumorigenic. The molecular specificity of this MCA-induced mutation resulting in C3H/10T$\frac{1}{2}$ tumorigenic transformants should provide an excellent system in which to study the roles of transcription, replication, repair, and exogenous factors in the establishment and expression of transformation and tumorigenicity.

20487 Prevention of the acute cytotoxicity associated with silica-containing minerals. Vallyathan, V.; Castranova, V.; Dalal, N.S.; Van Dyke, K. To Department of Health and Human Services, Washington, DC. USA Patent Application 7-429,033. 30 Oct 1989. 28p. Available from NTISPC N03/MF A01.

This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of application available NTIS.

The inventors have developed a method that may prevent the acute cytotoxicity of freshly fractured silica and silica containing minerals including asbestos and coal-mine dust containing silica. The method entails coating silica-containing minerals, including coal, with a monomolecular film of an aqueously compatible silane coupling agent, either during milling, processing or after grinding or fracturing of silica or silica-containing materials. The invention also provides for a method of preventing certain pulmonary diseases, have been considered as occupational hazards in certain professions, such as coal mining and any other profession where persons are subjected to the inhalation of small particles of freshly fractured or ground silica containing minerals.

5604 Other Environmental Pollutant Effects

20488 (AD-A-214006/9/XAB) **Treatment of laser-induced retinal injuries. Midterm report, 30 September 1987-31 March 1989.** Belkin, M.; Naveh, N. Tel Aviv Univ. (Israel). 21 Jun 1989. 29p. Available from NTIS, PC A03/MF A01.

Previously the authors have shown that the ocular response to laser-induced ocular injury is characterized by an enhancement in arachidonic acid metabolism and that steroid treatment curtailed this response. In this study, they investigated the involvement of leukotrienes B4 (LTB4) and the following parameters were studied: LTB4 production by the retina/choroid, its accumulation in the vitreous body, and changes in vitreal protein levels. The effect of an antileukotriene drug on the severity of the ocular inflammatory response was also studied. Their finding that the ocular response to laser-induced retinal injury involves an enhanced leukotriene B4 response might be responsible for edema formation and accumulation of various toxic substances in the vitreous body, with resultant immediate incapacitation of the affected individuals. Treatment to reduce leukotriene production might attenuate vision reduction.

20489 (AD-A-214212/3/XAB) **Analysis and evaluation of technical data on the photochromic and nonlinear optical properties of materials. Quarterly technical report No. 2.**

Cozzens, R.F. George Mason Univ., Fairfax, VA (USA). 1 Jun 1989. 23p. Available from NTIS, PC A03/MF A01.

The overall goal to this effort is to evaluate data on materials, especially polymers, that may be useful in the development of optical limiters for the protection of eyes and electro-optic sensors from exposure to damaging levels of laser radiation. A major task is to assist in the development of a predictive capability in assessing the viability of various protective approaches and to determine the theoretical limitations that may exist in the use of organic materials as optical switches and limiters.

20490 (PB–90-854746/XAB) **Biological effects of electrical or magnetic field application. April 1987-July 1989 (Citations from the Life Sciences Collection data base). Report for April 1987-July 1989.** National Technical Information Service, Springfield, VA (USA). Dec 1989. 49p. Available from NTISPC N01/MF N01.

Supersedes PB–89-863849.

This bibliography contains citations concerning the application of electrical or magnetic fields to organisms. Changes in cell structure, cell shape, metabolism, mitosis, cell orientation, neuron response, germination response, and growth rates are discussed. The effect of electrical or magnetic fields from transmission lines is examined. Biological applications of electric fields cited include genetic transfer, plant-cell fusion, and seed disinfection. (This updated bibliography contains 99 citations, 27 of which are new entries to the previous edition.)

57 HEALTH AND SAFETY

20491 (HAZ–CE02855, pp. 42-60) **Dangerous occurrences on Alberta highways.** Blower, L. Haztech Canada, Edmonton, AB (Canada). 1988. (CONF-8810478–: Haztech western Canada: hazardous waste management and environmental control conference, Edmonton (Canada), 5-6 Oct 1988; CE–02855). In *Haztech Western Canada '88: Hazardous waste management and environmental control conference proceedings.* Available from Haztech Canada, 4936-87th St., no. 26, Edmonton, AB, CAN T6E 5W3. Prices: $50.00 CAN.

The Federal Transportation of Dangerous Goods Act and Regulations have been in effect for more than 3 years. The Alberta counterpart of this is the Transportation of Dangerous Goods Control (TDGC) Act and Regulations, which were enacted shortly after the federal legislation. Since 1982, the Dangerous Goods Control Division of the Alberta Public Safety Services has had the responsibility of implementing and enforcing the provincial TDGC. Statistics are presented on dangerous goods movements and on dangerous occurrences. The coordination of the response for dangerous occurrences and the training of the responders are discussed. Approximately 250 road incidents have occurred in Alberta, since January 1986, which were of sufficient potential hazard to have required a written report. At this time, it is not known what proportion this represents of the total number of incidents. As more data are collected, it should be possible to identify the variables associated with accidents and to reduce their effect. A dangerous occurrence report form is annexed to this paper. 4 refs., 5 figs., 11 tabs.

58 GEOSCIENCES

Refer also to citation(s) 19257, 19262, 19388, 19389, 19529, 19608, 19983, 20153, 20342

20492 (LA-UR–89-3013) **Getting lunar ilmenite: From soils or rocks?.** Vaniman, D.T.; Heiken, G.H. Los Alamos National Lab., NM (USA). [1989]. 15p. Sponsored by U.S. DOE Defense Programs; National Aeronautics and Space Administration. DOE Contract W-7405-ENG-36. (CONF-900442–2: Engineering, construction and operations for space, Albuquerque, NM (USA), Apr 1990). Order Number DE90000538. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Lunar soils or rocks can be mined as sources of ilmenite for producing oxygen. However, separable crystals of loose ilmenite in lunar soils are rare (<2%) and small (<200 μ); most ilmenite in the regolith is locked together with silicate minerals as rock fragments. Since fragmentation of rock sources must be attempted to win appreciable amounts of ilmenite (~10% or more), selective collection of high-Ti basalt fragments larger than 1 cm for fragmentation and ilmenite beneficiation may be advantageous over extensive processing of fine lunar soil. Many alternative processing schemes for fragmenting rocks on the Moon have been proposed; one process which was tested early in the Apollo program successfully disaggregated lunar and terrestrial basalts by passive exposure to low-pressure alkali (K) vapor. This process is worthy of reinvestigation. 14 refs., 3 figs.

20493 (NEI-NO–71) **Resolution conference: Kristiansand S, Norway, 7-9 March 1988.** Norsk Petroleumsforening, Oslo (Norway). 1988. 313p. (CONF-8803252–: Resolution conference, Kristiansand (Norway), 7-9 Mar 1988). Order Number DE90748509. Available from NTIS (US Sales Only), PC A14/MF A01.

The report presents the lectures given at a conference dealing with the various methods and techniques used for increasing seismic survey resolution. The fields of seismic wave propagation and reflection, and also data analysis and processing are discussed. Separate abstracts are prepared for all the lectures. 132 figs., 5 tabs., 80 refs.

20494 (NEI-NO–71, pp. 2) **Marine acquisition parameters as a limiting factor for resolution.** Brink, M. Norsk Petroleumsforening, Oslo (Norway). 1988. (CONF-8803252–: Resolution conference, Kristiansand (Norway), 7-9 Mar 1988). In *Resolution conference, Kristiansand S (Norway), March 7-8, 1988.* Order Number DE90748509. Available from NTIS (US Sales Only), PC A14/MF A01.

Tolerances in marine acquisition parameters are traditionally described in so-called specs: specifications which are intended to guarantee a minimum geophysical performance. These specifications are often more based on tradition than on scientific considerations. Increased operational flexibility, combined with more advanced geophysical needs and better understanding of geophysical and economical consequences, has led to more interest in some of the acquisition parameters. The paper focuses on some of these acquisition parameters and considers their impact on potential resolution.

20495 (NEI-NO–71, pp. 1) **High resolution marine field techniques.** Wathne, S. (Esso Norge a.s. (Norway)). Norsk Petroleumsforening, Oslo (Norway). 1988. (CONF-8803252–: Resolution conference, Kristiansand (Norway), 7-9 Mar 1988). In *Resolution conference, Kristiansand S (Norway), March 7-8, 1988.* Order Number DE90748509. Available from NTIS (US Sales Only), PC A14/MF A01.

Abstract only. OIL FIELDS/marine surveys; SEISMIC SOURCES/performance; PERFORMANCE; CONTINENTAL SHELF; TERTIARY PERIOD; RESOLUTION; NORWAY

20496 (NEI-NO–71, pp. 10) **Source spectral shaping with the multipulse digital marine vibratory source.** Houston, M.H. (Western Research, Houston, TX (USA)). Norsk Petroleumsforening, Oslo (Norway). 1988. (CONF-8803252–: Resolution conference, Kristiansand (Norway), 7-9 Mar 1988). In *Resolution conference, Kristiansand S (Norway), March 7-8, 1988.* Order Number DE90748509. Available from NTIS (US Sales Only), PC A14/MF A01.

Digital coding techniques are used to precisely shape the source spectral output of a marine vibratory source that operates with digital hydraulics and a non-symmetric radiator waveform. Non-linear output sweeps with a 6 dB per octave spectral slope can be generated to cover 3, 3 1/2, and 4-octaves within a demonstrated operating frequency bandwidth of 5 to 120 Hz. Measured farfield signatures showed an equivalent source strength of 27 bar-m and a peak spectral amplitude of 203 dB Re 1 muPa - M/Hz after correlation for a 7.5 to 100 Hz, 10 s, non-linear sweep with a single module. Seismic sections gathered with a 4-module system demonstrate that increased resolution can be obtained by using this marine analog of the Vibroseis technique. 3 figs. (Author).

20497 (NEI-NO–71, pp. 23) **The "dual wavelet" technique for resolution enchancement in reflection seismology.** Carlini, A. (AGIP, Geophysic Research and Data Processing Department,

Milano (Italy)); Storer, P. Norsk Petroleumsforening, Oslo (Norway). 1988. (CONF-8803252–: Resolution conference, Kristiansand (Norway), 7-9 Mar 1988). In *Resolution conference, Kristiansand S (Norway), March 7-8, 1988.* Order Number DE90748509. Available from NTIS (US Sales Only), PC A14/MF A01.

Many different energy sources are used in the seismic exploration technology, each generating a typical wavelet having its own spectral characteristics and resolution limits. The choice of the source to be used in dependent on many factors, such as: economical considerations, environmental conditions, target type, desired resolution, earth response and depth of investigation. The aim of this work is to study the possibility of merging the records acquired with different sources, considering the various aspects of the problem: acquisition,processing and interpretation. The leading concept is to "illuminate" the subsurface with two wavelets of complementary characteristics, instead of a single wavelet, to better detail the geological interpretation of the area under study. 14 figs., 3 refs.

20498 (NEI-NO–71, pp. 6) **Increasing seismic resolution by integrated use of information.** Van Riel, P. (Jason Geosystems BV, Delft (Netherlands)). Norsk Petroleumsforening, Oslo (Norway). 1988. (CONF-8803252–: Resolution conference, Kristiansand (Norway), 7-9 Mar 1988). In *Resolution conference, Kristiansand S (Norway), March 7-8, 1988.* Order Number DE90748509. Available from NTIS (US Sales Only), PC A14/MF A01.

The traditional view on seismic resolution is that it is determined by temporal bandwidth and aperture. This is clearly recognized in conventional processing where the ultimate objective is, within the data bandwidth, to remove the effects of wave propagation by dephasing and flattening of the spectrum of the wave propagation operator. This is achieved by a combination of deconvolution and migration. When a less restrictive view on resolution is taken, there is room for the development of new technologies which can offer major improvements in resolution relative to the marginal improvements which can be made by improving existing, bandlimited processing technology. The point of view to take is that resolution is not determined by seismic data alone, but that it is determined by the total available information. It depends on the situation and application which additional information is available and how effective it is, e.g. exploration versus production and structural versus stratigraphic. The present paper discusses the model-based approach, difficulties which need to be overcome in practical application, and two examples showing the benefits. 2 figs.

20499 (NEI-NO–71, pp. 12) **Improvement of resolution by the application of prestack depth migration - some examples.** Schneider, J.F. (Prakla-Seismos AG, Hannover (Germany, F.R.)). Norsk Petroleumsforening, Oslo (Norway). 1988. (CONF-8803252–: Resolution conference, Kristiansand (Norway), 7-9 Mar 1988). In *Resolution conference, Kristiansand S (Norway), March 7-8, 1988.* Order Number DE90748509. Available from NTIS (US Sales Only), PC A14/MF A01.

Depth migration is in general applied in areas which show significant lateral velocity variations. Particularly when velocity contrasts occur at dipping horizons in the upper part of the geological structure, depth migration usually yields an improved result, compared to time migration. However, in these areas one usually finds that stacking of the data is difficult to achieve because of interfering events and rapidly varying stacking velocities. In some cases it leads to artificial events due to asymmetric reflection paths. Prestack applications avoid these problems provided the propagation velocities of the subsurface can be resolved in sufficient detail in terms of a so-called macro model. Examples given in the paper show that prestack shot migration can improve the resolution in areas with complex velocity structures. In particular with the redundancy of the data it is possible to exert some control on the velocity model. For converted waves first applications indicate that the processing of this data can be improved by migrating this wave type with the appropriate velocity fields. 6 figs., 4 refs.

20500 (NEI-NO–71, pp. 1) **Seismic resolution and the migration butterfly.** Devey, M.G. (BP Petroleum Development, Aberdeen (United Kingdom)); Bei-Lin, L. Norsk Petroleumsforening, Oslo (Norway). 1988. (CONF-8803252–: Resolution conference, Kristiansand (Norway), 7-9 Mar 1988). In *Resolution conference, Kristiansand S (Norway), March 7-8, 1988.* Order Number DE90748509. Available from NTIS (US Sales Only), PC A14/MF A01.

Abstract only. SEISMIC SURVEYS/wave propagation; SEISMOLOGY; RESOLUTION; RELIABILITY

20501 (NEI-NO–71, pp. 9) **High resolution stacking methods.** Naess, O. E. (Statoil, Stavanger (Norway)). Norsk Petroleumsforening, Oslo (Norway). 1988. (CONF-8803252–: Resolution conference, Kristiansand (Norway), 7-9 Mar 1988). In *Resolution conference, Kristiansand S (Norway), March 7-8, 1988.* Order Number DE90748509. Available from NTIS (US Sales Only), PC A14/MF A01.

Common Mid-Point stacking is an important step in the seismic processing sequence. The averaging employed in the conventional straight summation type of stacking is known to reduce the achievable resolution in the data. An important reason for this is the non-discriminatory use of the large-offset traces in the stack. Due to converging NMO-hyperbolas and frequency selective absorption the large-offset traces will generally have both a lower temporal and a lower lateral resolution than traces with less offset. In addition events on the long-offset traces will be more sensitive to incorrect stacking velocities. Three different stacking methods, which represents attempts to increase the final resolution by assigning relatively more importance to small-offset traces while retaining most of the attenuation power of conventional stacking towards noise, will be described and discussed. 5 refs. (Author).

20502 (NEI-NO–71, pp. 30) **Attenuation compensation and predictive deconvolution.** Doicin, D. (Compagnie Generale de Geophysique, London (United Kingdom)); Jones, I.F. Norsk Petroleumsforening, Oslo (Norway). 1988. (CONF-8803252–: Resolution conference, Kristiansand (Norway), 7-9 Mar 1988). In *Resolution conference, Kristiansand S (Norway), March 7-8, 1988.* Order Number DE90748509. Available from NTIS (US Sales Only), PC A14/MF A01.

Attenuation compensation is a time dependent spectral balancing technique designed to enhance resolution by restoring the amplitudes of attenuated high frequencies. It is not meant to restore lost information, and cannot broaden the bandwidth of the data. Once the signal amplitude at a given frequency has fallen below the post-stack noise level, that signal energy is lost. In the presence of shallow water related multiples, or inter-bed ringing, we often wish to employ a predictive deconvolution scheme. However, one of the corollaries of such multiple suppression is spectrum flattening, which, in the presence of noice, may negate the effects of inverse Q filtering. The paper describes the effect of noise on predictive deconvolution, and on the interaction of deconvolution with attenuation compensation, concluding with some observations on the validity of combining statistical and deterministic methods. 11 figs., 9 refs.

20503 (NEI-NO–71, pp. 12) **Detection of zero-offset seismic reflections.** Landroe, M. (Seismic Research and Development A/S, Trondheim (Norway)); Ursin, B. Norsk Petroleumsforening, Oslo (Norway). 1988. (CONF-8803252–: Resolution conference, Kristiansand (Norway), 7-9 Mar 1988). In *Resolution conference, Kristiansand S (Norway), March 7-8, 1988.* Order Number DE90748509. Available from NTIS (US Sales Only), PC A14/MF A01.

In one-dimensional seismic inversion one may either estimate the acoustic impedance as a function of two-way traveltime or one may identify discrete layers. The latter approach is chosen assuming that the subsurface consists of horizontal layers, where each layer is characterized by three parameters: the wave propagation velocity, the density, and the thickness. In principle, it is possible to estimate both the velocity and the density of each layer using the amplitude and traveltime of both primary and multiple reflected pulses. In practice, however, this procedure is unstable. Therefore the geometrical spreading is computed from known stacking velocities, and only the acoustic impedance of each layer is estimated. From a known pulse and zero-offset seismic data, the primary reflections are estimated using a least-squares detection scheme. Geometrical spreading and transmission losses are corrected for and multple reflections may also be taken into account. The output from the procedure is a section consisting of reflection coefficients as a function of two-way traveltime or depth. The reflection coefficients are computed in true amplitude since all elastic wave

propagation effects for a point source have been taken into account. Data examples are presented with zero-offset seismic data and a measured seismic pulse. 5 figs, 8 refs.

20504 (NEI-NO–71, pp. 17) **Testing nonlinear 2D acoustic seismic inversion on horizontally stratified prestack field data.** Hindlet, F. (Elf Aquitaine, div. of Geological and Geophysical Research, Pau (France)); Kolb, P. Norsk Petroleumsforening, Oslo (Norway). 1988. (CONF-8803252–: Resolution conference, Kristiansand (Norway), 7-9 Mar 1988). In *Resolution conference, Kristiansand S (Norway), March 7-8, 1988.* Order Number DE90748509. Available from NTIS (US Sales Only), PC A14/MF A01.

Resolving prestack seismic reflection data into velocity and density information can be accomplished through a nonlinear 2D acoustic seismic inversion method. On large scale numerical data (synthetic common mid-point sections) the method has successfully recovered velocity and density information (in the source frequency bandwith) as well as the low frequency velocity component. Retrieval of the source signature, a recent addition to this inversion scheme, was one of the final steps needed before attempting to run tests on field data. In the inversion of field data three significant components are sought such as source wavelet, low frequency velocity, and velocity and density in the source frequency bandwidth. Each of these components embodies a step in the inversion continuation process where increasingly higher frequencies, longer times and offsets are included. These continuations are used to aid in the convergence and stability of the process thus reducing the chances of falling into local minima. 8 figs., 3 refs.

20505 (NEI-NO–71, pp. 38) **The effect of sample rate on synthetic seismogram generation using transition probability matrices.** Griffiths, C.M. (Continental Shelf and Petroleum Technology Research Institute, Trondheim (Norway)). Norsk Petroleumsforening, Oslo (Norway). 1988. (CONF-8803252–: Resolution conference, Kristiansand (Norway), 7-9 Mar 1988). In *Resolution conference, Kristiansand S (Norway), March 7-8, 1988.* Order Number DE90748509. Available from NTIS (US Sales Only), PC A14/MF A01.

Prediction can occur in two directions, we can use seismic data to predict the location of a particular boundary in a rock sequence, or we can use a model of the depositional sequence to predict the seismic reflection pattern. In the latter case this predicted reflection pattern can then be tested against reality, and the model adjusted until we have a satisfactory fit. The success of this second approach depends on having both an appropriate means of describing the depositional sequence, and an adequate means of translating this into a synthetic seismogram. The use of transition matrices has always seemed a reasonable approach to seismic modelling because the nature of the vertical acoustic reflection is a function of the vertical transition between two differing density-velosity states. Thus there is an expected relationship between sediment sequence derived transition probality matrices and ic response characteristics. Since seism seismic data have a practical resolution limit of around ten metres at reservoir depths, and log data are available at 20cm to 60cm resolution, we must have some reliable way of both handling the transition from one resolution to another, and ensuring that the gross lithological characteristics remain stable under such a transition. This paper presents an approach to this problem, based on the use of numerical lithology derived from velocity and density data. Examples of synthetic seismogram generation from sediment sequences simulated at different resolutions are presented from Norwegian fields. 10 figs., 14 refs. (Author).

20506 (NEI-NO–71, pp. 17) **The resolution of thin layers in elastic synthetic seismograms.** Wrolstad, K.H. (Unocal Science and Technology, Brea, CA (USA)). Norsk Petroleumsforening, Oslo (Norway). 1988. (CONF-8803252–: Resolution conference, Kristiansand (Norway), 7-9 Mar 1988). In *Resolution conference, Kristiansand S (Norway), March 7-8, 1988.* Order Number DE90748509. Available from NTIS (US Sales Only), PC A14/MF A01.

The resolution of thin layers in the earth's subsurface was investigated using non-normal incidence, plane-layer, elastic synthetic modeling. Model complexity ranged from single layers imbedded in a homogeneous shale to models having over 100 layers including many thin beds that simulate the Brent zones found in the North Sea. Material properties were appropriate for water and hydrocarbon saturated sands, shales, and carbonates. Pre-stack attributes of the synthetic traces were computed in order to investigate reflection and transmission propagation effects. It was found that tuning and multiple interference must be considered in the interpretation of amplitude with offset. In addition, converted shear events must be identified as they always have increasing amplitude versus offset (AVO). Angle dependent attenuation occurs upon transmission of elastic waves through the overburden. This paper shows that amplitude and phase attributes of partial stack traces are very useful for observing very subtle changes in wave shape caused by these propagation effects. A solution is offered for the estimation of layer thickness in complex field seismograms using pre-stack syntheticks. By plotting a cross-semblance measure between a specific window of NMO corrected field and synthetic gathers, the lateral total Brent thickness was measured including the Brent Layer 1 thickness, even though the target zone was composed of many thin layers and the seismogram was contaminated by multiples. 10 figs., 1 tab., 4 refs. (Author).

20507 (NEI-NO–71, pp. 1) **High resolution reservoir delineation from 3-component offset VSP data.** Alam, A. (Western Geophysical Company, London (England)). Norsk Petroleumsforening, Oslo (Norway). 1988. (CONF-8803252–: Resolution conference, Kristiansand (Norway), 7-9 Mar 1988). In *Resolution conference, Kristiansand S (Norway), March 7-8, 1988.* Order Number DE90748509. Available from NTIS (US Sales Only), PC A14/MF A01.

Abstract only. SEISMIC SURFACE WAVES/well logging; SEISMIC SURVEYS; RESOLUTION; SIGNAL-TO-NOISE RATIO; SEISMIC DETECTION

20508 (NEI-NO–71, pp. 7) **Vertical seismic resolution, inversion, and the lateral coverage VSP.** Eaton, M.R. (Seismograph Service Ltd. (England)). Norsk Petroleumsforening, Oslo (Norway). 1988. (CONF-8803252–: Resolution conference, Kristiansand (Norway), 7-9 Mar 1988). In *Resolution conference, Kristiansand S (Norway), March 7-8, 1988.* Order Number DE90748509. Available from NTIS (US Sales Only), PC A14/MF A01.

The paper demonstrate that the conflict which faces the human intepreter between resolution and wavelet sidelobe interference can be substantially reduced using a modern "structural deconvolution" algorithm. As far as inversion is concerned, the limits of resolution caused by missing high frequencies is not so severe a problem as the uncertainties introduced by missing low frequencies in the data. Fortunately, this low frequency information can be regained by using a nearby velocity profile. What is more, the low frequency velocity profile can be extrapolated away from the borehole to provide a degree of lateral coverage. Confirmation of the robustness of this process was made by inverting a deviated well VSP and comparing the result to an independent acoustic log which intersected this well. Finally, it was shown that surface seismic data can also be successfully inverted to provide absolute values of velocity (or impedance), providing there is a borehole in the vicinity with which to calibrate the seismic data. 5 figs., 4 refs. (Author).

20509 (NEI-NO–71, pp. 9) **Dense spatial sampling of zero-offset VSP's.** Petersen, S.A. (Norsk Hydro Research Centre, Norsk Hydro A.S., Bergen (Norway)). Norsk Petroleumsforening, Oslo (Norway). 1988. (CONF-8803252–: Resolution conference, Kristiansand (Norway), 7-9 Mar 1988). In *Resolution conference, Kristiansand S (Norway), March 7-8, 1988.* Order Number DE90748509. Available from NTIS (US Sales Only), PC A14/MF A01.

During the last decade the acquisition of zero-offset VSP's has become a mandatory part of the logging program. The main purpose of collecting downhole recordings is first of all to establish the true vertical time/depth relationship within the seismic frequency band of 5-70 Hz. Secondly the processed VSP data are applied in the 'tieing' process to correlate the VSP derived reflection pattern with that obtained in the HSP stack or in the synthetic sections as wall. Basically two main types of wavefields are to be expected in the observations. The first type consists of propagating approximately plane waves with P or S polarizations. The second type is related to the well in terms of surface waves along the well or

other sorts of scattered energies. This type has a radial behaviour. In this paper the necessity of dense vertical sampling is demonstrated with respect to event identification/enchancement and lithological prediction. 5 figs., 6 refs. (Author).

20510 (NEI-NO–71, pp. 1) **The significance of Fresnel zones in seismic exploration.** Berkhout, A.J. (Delft University of Technology, Delft (Netherlands)); Wapenaar, C.P.A. Norsk Petroleumsforening, Oslo (Norway). 1988. (CONF-8803252–: Resolution conference, Kristiansand (Norway), 7-9 Mar 1988). In *Resolution conference, Kristiansand S (Norway), March 7-8, 1988.* Order Number DE90748509. Available from NTIS (US Sales Only), PC A14/MF A01.

Abstract only. SEISMIC SURVEYS/wave propagation; SEISMIC SURVEYS/acoustic measurements; FRESNEL COEFFICIENT; EVALUATION; RESOLUTION; REFRACTION

20511 (NEI-NO–71, pp. 32) **The role of 2D and 3D seismic in field development.** Jones, T.P. (Britoil Plc, Glasgow (United Kingdom)). Norsk Petroleumsforening, Oslo (Norway). 1988. (CONF-8803252–: Resolution conference, Kristiansand (Norway), 7-9 Mar 1988). In *Resolution conference, Kristiansand S (Norway), March 7-8, 1988.* Order Number DE90748509. Available from NTIS (US Sales Only), PC A14/MF A01.

The validity of indiscriminate acquisition of 3D seismics is questioned especially during the exploration and appraisal phase an oilfield's development. Although 3D data which were acquired more than 10 years ago can be improved by modern processing techniques, it can be demonstrated that the data often lack the resolution of 2D data and that cross line are always inferior to the inline data. Most North Viking Graben oil filds have 3D surveys shot over the field but the structures are mainly elongate ridges along the crests of large tilted fault blocks and the structures can be successfully imaged using 2D. The problem in the North Viking Graben fields is therefore not a three dimensional structural one but rather one of resolution of the thin Humber and Brent intervals on the crests of the fields. It is demonstrated that current 3D seismics have poorer resolution than 2D and that more information can be gained by acquiring high quality, high density 2D data (i.e. line spacing of c.200m). It is concluded that seismic surveys should be designed to solve specific problems with 3D surveys only being acquired if the problem is truly three dimensional. Current 3D seismics give poorer resolution, both temporal and spatial, than 2D and care must be taken in defining the problem. If resolution is the major problem then consideration must be given to acuiring high density 2D data. The timing of shooting the definitive development seismic survey is crucial. 8 figs., 3 tabs., 6 refs. (Author).

20512 (NEI-NO–71, pp. 12) **Vertical and horizontal resolution of 3D seismic surveys.** Dorn, G.A. (Arco oil and Gas Company, Plano, TX (USA)). Norsk Petroleumsforening, Oslo (Norway). 1988. (CONF-8803252–: Resolution conference, Kristiansand (Norway), 7-9 Mar 1988). In *Resolution conference, Kristiansand S (Norway), March 7-8, 1988.* Order Number DE90748509. Available from NTIS (US Sales Only), PC A14/MF A01.

The cost of 3D surveys has recently been reduced to a level where they are at times considered economic for exploration purposes, the primary use of these surveys remains in the areas of reservoir delineation and development, enchanced oil recovery planning and monitoring, and in reservoir extension. In these applications, 3D seismology is used precisely for the structural and stratigraphic resolution it can provide. Because of this it is important that we understand quantitatively what controls resolution. Given this understanding acquisition, processing, and interpretation can be planned to achieve the resolution required for a given target with the minimum effort and expense. This paper is intended to provide an overview of the resolution problem in 3D seismology. 6 figs., 1 tab., 5 refs. (Author).

20513 (NEI-NO–71, pp. 7) **Seismic data: Resolution in display.** Forsund, S. (Geophysical Service Int., Stavanger (Norway)); Monk, D.J. Norsk Petroleumsforening, Oslo (Norway). 1988. (CONF-8803252–: Resolution conference, Kristiansand (Norway), 7-9 Mar 1988). In *Resolution conference, Kristiansand S (Norway), March 7-8, 1988.* Order Number DE90748509. Available from NTIS (US Sales Only), PC A14/MF A01.

The trend for increased resolution in seismic exploration has lead to finer spatial sampling of the subsurface, and given rise to a corresponding increase in the trace density on the final seismic section. For a standard 1 : 25000 display scale, a CDP trace interval of 3.125 metres leads to a trace density of 80 traces /cm. At this trace interval many display devices produce a section which is visually poor, and some of the benefits of improved resolution are lost in the final dispalay. Display schemes which involve plotting only some of the traces (with or without mixing of the data), must of course lose some of the detail and thus resolution. The paper shows data displayed with a new generation of display device. 3 figs., 2 refs. (Author).

20514 (NEI-NO–71, pp. 7) **Use of pattern recognition techniques to increase resolution.** Snydsman, W.E. (Unocal Science and Technology Division, Brea, CA (USA)). Norsk Petroleumsforening, Oslo (Norway). 1988. (CONF-8803252–: Resolution conference, Kristiansand (Norway), 7-9 Mar 1988). In *Resolution conference, Kristiansand S (Norway), March 7-8, 1988.* Order Number DE90748509. Available from NTIS (US Sales Only), PC A14/MF A01.

Pattern recognition techniques are now being used in geophysical exploration to extract detailed stratigraphic and lithologic information from seismic data. These techniques can reduce large amounts of seismic data and attributes to a small number of patterns which the interpreter can easily handle. At the same time they appear to increase seismic resolution by separating subtle differences in the data into separate groups. The use of cluster analysis techniques shows good promise for distinguishing these subtle differences that may be geologically significant. 3 figs.

20515 (NEI-NO–71, pp. 7) **Resolution of seismic velocities.** Smith, P. (Geophysical Service Int., Stavanger (Norway)); Monk, D.J. Norsk Petroleumsforening, Oslo (Norway). 1988. (CONF-8803252–: Resolution conference, Kristiansand (Norway), 7-9 Mar 1988). In *Resolution conference, Kristiansand S (Norway), March 7-8, 1988.* Order Number DE90748509. Available from NTIS (US Sales Only), PC A14/MF A01.

The primary method used by the seismic data processing industry to determine seismic velocities is to measure the arrival times of seismic reflections at the various offsets within a common depth point gather. The times and offsets are related to velocity via the well known Dix equation. We shall refer to this method as "velocity analysis" throughout this paper, although the term is used more loosely in the industry to describe all methods of deriving seismic velocities. In this paper it is tried to give a brief overview of the current state of the art in velocity analysis and its usefulness in the seismic data processing industry. Experience shows that , with good quality data sets, it is possible to routinely estimate stacking velocity with errors of better than 3 %, and frequently substantially better than this. The accuracy with which this can be converted to other velocity types is dependent largely on the complexity of the geological structure. 2 figs. (Author).

20516 (NEI-NO–71, pp. 18) **A study of detectability and resolution of a complex structure by seismic survey modelling and synthetic data processing.** Froeyland, L.A. (Norsk Hydro A/S. Research Centre, Bergen (Norway)); Helle, H.B.; Riste,P.; Sandoe, I. Norsk Petroleumsforening, Oslo (Norway). 1988. (CONF-8803252–: Resolution conference, Kristiansand (Norway), 7-9 Mar 1988). In *Resolution conference, Kristiansand S (Norway), March 7-8, 1988.* Order Number DE90748509. Available from NTIS (US Sales Only), PC A14/MF A01.

Seismic modelling has become an important tool in all stages of seismic exploration. The present paper will deal with the use of 2-D modelling to evaluate possibilities and limitations of the seismic method for a given geological situation. Seismic modelling is used to evaluate the possibilities contained in a conventional seismic survey of detecting small dipping reflector segments at great depths. The output from the modelling exercise is then used in the evaluation of various processing procedures. Finally, the effects of anelastic attenuation and signal/noise ratio will be outlined and discussed. 13 figs., 4 refs. (Author).

20517 (NEI-NO–71, pp. 7) **Seismic resolution of Unit II of the Tomma FM on Midgard-case study.** Karlsen, Aa. (Saga

Petroleum A.S., Oslo (Norway)); Staerkeby, J. Norsk Petroleumsforening, Oslo (Norway). 1988. (CONF-8803252–: Resolution conference, Kristiansand (Norway), 7-9 Mar 1988). In *Resolution conference, Kristiansand S (Norway), March 7-8, 1988.* Order Number DE90748509. Available from NTIS (US Sales Only), PC A14/MF A01.

The main Midgard reservoir is the Tomma Formation, which usually is separated into three units. The upper and lower units, referred to as Unit I and III, are sandstone bodies which are 50 m and 70 m thick respectively. The middle Unit II is a 14-25 m thick shale layer which divides the Tomma Formation into two separate reservoirs. Although the base and the top of Unit II both should cause strong seismic reflections, interference and the limit bandwidth of the seismic have not made it possible to map the two horizons with the required accuracy from ordinary surface seismic data. In this case study it will be shown that it is possible to define both the upper and lower boundary of this layer. 6 figs. (Author).

20518 (NEI-NO–71, pp. 2) **Diagenetic origin of a crosscutting flat seismic reflection, offshore North Norway, compered with crosscutting reflections of different origins.** Petersen, M.D. (Conoco Inc. R and D, Ponca City, OK (USA)). Norsk Petroleumsforening, Oslo (Norway). 1988. (CONF-8803252–: Resolution conference, Kristiansand (Norway), 7-9 Mar 1988). In *Resolution conference, Kristiansand S (Norway), March 7-8, 1988.* Order Number DE90748509. Available from NTIS (US Sales Only), PC A14/MF A01.

Abstract only. SEISMIC SURVEYS/diagenesis; SEISMIC DETECTION/reflectivity; DIAGENESIS; CONTINENTAL SHELF; REFLECTIVITY; WELL LOGGING; NORWAY

20519 (NEI-NO–71, pp. 11) **Accurate twin streamer shape derivation using acoustic multi-path ranging.** Court, J.N. (Horizon Exploration Ltd., Swanley, Kent (United Kingdom)). Norsk Petroleumsforening, Oslo (Norway). 1988. (CONF-8803252–: Resolution conference, Kristiansand (Norway), 7-9 Mar 1988). In *Resolution conference, Kristiansand S (Norway), March 7-8, 1988.* Order Number DE90748509. Available from NTIS (US Sales Only), PC A14/MF A01.

Oceanic conditions are such that seismic streamers rarely follow directly behind the vessel. A slight cross-current will cause the streamers to stray off the survey line, resulting in sub-surface coverage which is displaced laterally from the line. Thus, although the absolute (geodetic) position of the vessel is known whithin an acceptable accuracy, the relative position of the steamer(s) may vary in an unknown way and this variation may differ considerably from one line to the next. If the streamer location is known, then the effects of an uneven spacing on the seismic data can be compensated for in processing. A model is used to generate a set of zero offset seismic traces which have a known random variation about a set of regularly spaced 25 m survey lines. Two major problems arise with the use of compasses. Firstly, it is not possible to calibrate them in their operational positions. Secondly, the derived streamer shape depends critically on the assumptions made about the complexity of the streamer shape and the degree of averaging between compass readings. With the advent of multi-steamer seismic profiling there is a unique opportunity to exploit the system geometry to achieve an independant means of determining the shapes of the individual streamers by ranging between them. The paper describes a concept and formulates the design of a practical system. A set of compass results are compared with typically observed values. 6 figs.

20520 (NEI-NO–71, pp. 9) **High-resolution shallow seismic surveying using parametric acoustic source technology.** Vestrheim, M. (Chr.Michelsen Institute, Dept. of science and Technology, Bergen (Norway)); Lunde, P.; Meldahl, P.; Statoil. Norsk Petroleumsforening, Oslo (Norway). 1988. (CONF-8803252–: Resolution conference, Kristiansand (Norway), 7-9 Mar 1988). In *Resolution conference, Kristiansand S (Norway), March 7-8, 1988.* Order Number DE90748509. Available from NTIS (US Sales Only), PC A14/MF A01.

The paper briefly discusses the potentials of using parametric source technology for improving shallow gas surveying operations. The use of a parametric source offers several important advantageous features, such as a broad frequency bandwidth, flexibility in pulse shaping, improved stability and repeatability, and high directivity. Through optimization of performance the application of parametric source technology for shallow gas surveying is seen to be technologically feasible. 6 figs., 3 refs. (Author).

20521 **Mechanical model of an earthquake fault.** Carlson, J.M. (Institute for Theoretical Physics, University of California, Santa Barbara, California 93106 (US)); Langer, J.S. *Physical Review [Section] A: General Physics (USA),* 40(11): 6470-6484 (1 Dec 1989).

We examine the dynamic behavior of a simple mechanical model of an earthquake fault. This model, introduced originally by Burridge and Knopoff [Bull. Seismol. Soc. Am. 57, 341 (1967)], consists of an elastically coupled chain of masses in contact with a moving rough surface. Our version of the model retains the full Newtonian dynamics with inertial effects and contains no externally imposed stochasticity or spatial inhomogeneity. The only nonlinear feature is a velocity-weakening stick-slip friction force between the masses and the moving surface. This system is being driven persistently toward a slipping instability and, therefore, exhibits noisy sequences of earthquakelike events. We observe these events in numerical simulations and are able to predict many of their features analytically. Their size distributions are found numerically to be consistent with the Gutenberg-Richter law. Some aspects of the size distributions can be understood by scaling arguments.

64 PHYSICS I

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20522 (CEA-CONF–9406) **Early nucleosynthesis, particle physics and the quark-lithium connection.** CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Fondamentale (IRF); Centre National de la Recherche Scientifique, 75 - Paris (France). 1987. 10p. (CONF-8708165–: Symposium on the origin and distribution of elements, New Orleans, LA (USA), 31 Aug - 4 sep 1987). Order Number DE90752596. Available from NTIS (US Sales Only), PC A02/MF A01.

Three questions relevant to the primordial nucleosynthesis of the very light elements are discussed in this contribution: 1. It is argued that the "standard" Big Bang nucleosynthesis models are strenghtened if D is destroyed thoroughly during the galactic history. This can be achieved by specific models of chemical evolution of galaxies like those assuming a rate of star formation varying with time. 2. The existence of non baryonic particles such as massive neutrinos or supersymetric particles (gravitinos, photinos ...) might affect this early nucleosynthesis. If they are massive (ge 500 MeV) and long lived enough (ge 10^5 sec) the energetic photons released by their possible decay might affect the relative abundances of the light elements. In the case of the photinos, which are the supersymetric particles and which might be experimentally detectable in a near future, this possible effect can be used as to constrain the predictions on their physical properties (mass, lifetime...). 3. The early nucleosynthesis can be affected by the inhomogeneities triggered by the quark-hadron phase transition. It is argued that the primordial abundance of ^{7}Li limits very severely this possibility. As in the case of photinos the relation between the early synthesis of ^{7}Li and the characteristics of this quark-hadron phase transition may provide interesting constraints on some important physical parameters such as the constant B of the quark-bag model.

20523 (ESA-SP–1104, pp. 7-12) **SOHO: An observatory to study the solar interior and the solar atmosphere.** Domingo, V. (European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands)); Poland, A.I. European Space Agency, 75 - Paris (France). Nov 1988. (ETN–89-94988;CONF-8806454–: The SOHO science working team conference, Greenbelt, MD (USA), 27-30 Jun 1988). In *The SOHO mission. Scientific and technical*

aspects of the instruments. Available from NTIS, PC A05/MF A01; ESA Publications Div., ESTEC, Noordwijk, Netherlands, 25 Dutch guilders or 12 U.S. dollars.

The Solar and Heliospheric Observatory (SOHO) is described. The two main objectives of SOHO are to improve understanding of solar coronal phenomena and to study solar structure and interior dynamics from its core to the photosphere. The primary goals of the coronal and solar wind studies are to understand the coronal heating mechanism and its expansion into the solar wind. These goals will be achieved both by remote sensing of the solar atmosphere with high resolution spectrometers and telescopes and by in situ measurement of the composition and energy of the resulting solar wind and the energetic particles that propagate through it. The structure and interior dynamics are to be studied by helioseismological methods and the measurement of solar irradiance variations. The SOHO spacecraft will be three-axis stabilized and located in a halo orbit around the L1 Lagrangian point (approximately 1 percent of the distance from the Earth to the Sun). It is currently scheduled for launch in July 1995.

20524 (ESA-SP–1104, pp. 25-30) **SOI: The Solar Oscillations Imager on SOHO.** Scherrer, P.H. (Cambridge Univ. (England)); Hoeksema, J.T.; Bogart, R.S.; Walker, A.B.C. Jr.; Title, A.M.; Tarbell, T.D.; Wolfson, C.J.; Brown, T.M. Jr.; Christensen-Dalsgaard, J.; Gough, D.O. European Space Agency, 75 - Paris (France). Nov 1988. (ETN–89-94988;CONF-8806454–: The SOHO science working team conference, Greenbelt, MD (USA), 27-30 Jun 1988). In *The SOHO mission. Scientific and technical aspects of the instruments.* Available from NTIS, PC A05/MF A01; ESA Publications Div., ESTEC, Noordwijk, Netherlands, 25 Dutch guilders or 12 U.S. dollars.

The Solar Oscillations Imager (SOI) program for SOHO (solar and heliospheric observatory) is described. It will consist of a Michelson Doppler Imager (MDI) instrument, a facility providing data reduction and analysis capability, and a coordinated set of investigations designed to address a set of science objectives. The MDI is designed to take advantage of the anticipated SOHO telemetry by organizing the observations into four observation programs: structure (at all times), dynamics (two months per year), campaign (eight hours per day, ten months per year), and magnetic fields (few minutes per day). The MDI will measure line-of-sight velocity by Doppler shift, transverse velocity by local correlation tracking, line and continuum intensity, and line-of-sight magnetic fields with both 4 and 1.4 arc-second resolution (2 and 0.7 arc-sec pixels respectively).

20525 (ESA-SP–1104, pp. 31-37) **SUMER: Solar Ultraviolet Measurements of Emitted Radiation.** Wilhelm, K. (Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau (Germany, F.R.)); Axford, W.I.; Curdt, W.; Gabriel, A.H.; Grewing, M.; Huber, M.C.E.; Jordan, M.C.E.; Lemaire, P.; Marsch, E.; Poland, A.I. European Space Agency, 75 - Paris (France). Nov 1988. (ETN–89-94988;CONF-8806454–: The SOHO science working team conference, Greenbelt, MD (USA), 27-30 Jun 1988). In *The SOHO mission. Scientific and technical aspects of the instruments.* Available from NTIS, PC A05/MF A01; ESA Publications Div., ESTEC, Noordwijk, Netherlands, 25 Dutch guilders or 12 U.S. dollars.

The SUMER (solar ultraviolet measurements of emitted radiation) experiment is described. It will study flows, turbulent motions, waves, temperatures and densities of the plasma in the upper atmosphere of the Sun. Structures and events associated with solar magnetic activity will be observed on various spatial and temporal scales. This will contribute to the understanding of coronal heating processes and the solar wind expansion. The instrument will take images of the Sun in EUV (extreme ultra violet) light with high resolution in space, wavelength and time. The spatial resolution and spectral resolving power of the instrument are described. Spectral shifts can be determined with subpixel accuracy. The wavelength range extends from 500 to 1600 angstroms. The integration time can be as short as one second. Line profiles, shifts and broadenings are studied. Ratios of temperature and density sensitive EUV emission lines are established.

20526 (ESA-SP–1104, pp. 43-48) **EIT: Solar corona synoptic observations from SOHO with an extreme-ultraviolet imaging telescope.** Delaboudiniere, J.P. (Lockheed Aircraft Corp., Palo Alto, CA (USA)); Gabriel, A.H.; Artzner, G.E.; Michels, D.J.; Dere, K.P.; Howard, R.A.; Catura, R.; Stern, R.; Lemen, J.; Neupert, W. European Space Agency, 75 - Paris (France). Nov 1988. (ETN–89-94988;CONF-8806454–: The SOHO science working team conference, Greenbelt, MD (USA), 27-30 Jun 1988). In *The SOHO mission. Scientific and technical aspects of the instruments.* Available from NTIS, PC A05/MF A01; ESA Publications Div., ESTEC, Noordwijk, Netherlands, 25 Dutch guilders or 12 U.S. dollars.

The Extreme-ultraviolet Imaging Telescope (EIT) of SOHO (solar and heliospheric observatory) will provide full disk images in emission lines formed at temperatures that map solar structures ranging from the chromospheric network to the hot magnetically confined plasma in the corona. Images in four narrow bandpasses will be obtained using normal incidence multilayered optics deposited on quadrants of a Ritchey-Chretien telescope. The EIT is capable of providing a uniform one arc second resolution over its entire 50 by 50 arc min field of view. Data from the EIT will be extremely valuable for identifying and interpreting the spatial and temperature fine structures of the solar atmosphere. Temporal analysis will provide information on the stability of these structures and identify dynamical processes. EIT images, issued daily, will provide the global corona context for aid in unifying the investigations and in forming the observing plans for SOHO coronal instruments.

20527 (ESA-SP–1104, pp. 49-54) **UVCS: An Ultraviolet Coronagraph Spectrometer for SOHO.** Kohl, J.L. (Maryland Univ., College Park (USA)); Hartmann, L.W.; Vanballegooijen, A.A.; Withbroe, G.L.; Raymond, J.C.; Weiser, H.; Noci, G.; Antonucci, E.; Geiss, J.; Gloeckler, G. European Space Agency, 75 - Paris (France). Nov 1988. (ETN–89-94988;CONF-8806454–: The SOHO science working team conference, Greenbelt, MD (USA), 27-30 Jun 1988). In *The SOHO mission. Scientific and technical aspects of the instruments.* Available from NTIS, PC A05/MF A01; ESA Publications Div., ESTEC, Noordwijk, Netherlands, 25 Dutch guilders or 12 U.S. dollars.

The UltraViolet Coronagraph Spectrometer (UVCS) of SOHO (solar and heliospheric observatory) provides ultraviolet spectroscopic observations of the solar corona out to ten solar radii from suncenter. This capability is expected to greatly expand the number of plasma parameters that can be specified by remote sensing techniques. Plasma diagnostic techniques are expected to provide a sufficient number of empirically derived parameters to significantly constrain theories of solar wind acceleration, coronal heating, and solar wind composition. The spectral line profiles and intensities are sensitive to random velocity distributions and to the effective temperatures of protons, minor ions, and electrons. Ion densities, chemical abundances, and outflow velocities of coronal protons and ions into the solar wind are also taken into consideration.

20528 (ESA-SP–1104, pp. 75-80) **COSTEP: A comprehensive suprathermal and energetic particle analyzer for SOHO.** Kunow, H. (Ehime Univ., Matsuyama (Japan)); Fischer, H.; Green, G.; Mueller-Mellin, R.; Wibberenz, G.; Holweger, H.; Evenson, P.; Meyer, J.; Hasebe, N.; Vonrosenvinge, T. European Space Agency, 75 - Paris (France). Nov 1988. (ETN–89-94988;CONF-8806454–: The SOHO science working team conference, Greenbelt, MD (USA), 27-30 Jun 1988). In *The SOHO mission. Scientific and technical aspects of the instruments.* Available from NTIS, PC A05/MF A01; ESA Publications Div., ESTEC, Noordwijk, Netherlands, 25 Dutch guilders or 12 U.S. dollars.

The group of instruments involved in the COSTEP (comprehensive suprathermal and energetic particle analyzer) project are described. Three sensors, the LION (low energy ion and electron) instrument, the MEICA (medium energy ion composition analyzer) and the EPHIN (electron proton helium instrument) are described. They are designed to analyze particle emissions from the sun over a wide range of species (electrons through iron) and energies (60 KeV/particle to 500 MeV/nucleon). The data collected is used in studying solar and space plasma physics.

20529 (ESA-SP–1104, pp. 55-61) **LASCO: A wide-field white light and spectrometric coronagraph for SOHO.** Michels, D.J. (Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau (Germany, F.R.)); Schwenn, R.; Howard, R.A.; Bartoe, J.D.F.; Antiochos, S.K.; Brueckner, G.E.; Cheng, C.C.; Dere, K.P.; Doschek, G.A.; Mariska, J.T. European Space Agency, 75 - Paris (France). Nov 1988.

(ETN–89-94988). In *The SOHO mission. Scientific and technical aspects of the instruments.* Available from NTIS, PC A05/MF A01; ESA Publications Div., ESTEC, Noordwijk, Netherlands, 25 Dutch guilders or 12 U.S. dollars.

The scientific objectives of the LASCO (light and spectrometric coronagraph) project in the SOHO (solar and heliospheric observatory) mission are described. These include investigation of mechanisms for heating of the corona and acceleration of the solar wind, causes of coronal transients, and their role in development of large scale coronal patterns and interplanetary disturbances. The distribution and properties of dust particles, including those released from sun-grazing comets are investigated. Interactions of coronal plasma with the dust are studied. The corona is analyzed spectroscopically by a high-resolution scanning, imaging interferometer. The spectral profiles of three emission lines and one Fraunhofer line are measured for each picture point, giving temperatures, velocities, turbulent motions and volume densities. Polarization analysis yields the direction of coronal magnetic fields.

20530 (LA-UR–90-42) **The Advanced Composition Explorer.** Stone, E.C. (California Inst. of Tech., Pasadena, CA (USA)); Cummings, A.C.; Mewaldt, R.A.; Burlaga, L.F.; Rosenvinge, T.T. von; Feldman, W.C.; McComas, D.; Geiss, J.; Gloeckler, G.; Mason, G.M. Los Alamos National Lab., NM (USA). [1989]. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-8911161–2: Particle astrophysics: NASA cosmic ray program for the 1990's and beyond, Greenbelt, MD (USA), 6-8 Nov 1989). Order Number DE90006522. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Advanced Composition Explorer (ACE) was recently selected as one of two new Explorer-class missions to be developed for launch during the mid-1990's. ACE will observe particles of solar, interplanetary, interstellar, and galactic origins, spanning the energy range from that of the solar wind (~1 keV/nucleon) to galactic cosmic ray energies (several hundred MeV/nucleon). Definitive studies will be made of the abundance of nearly all isotopes from H to Zn ($1 \leq Z \leq 30$), with exploratory isotope studies extending to Zr ($Z = 40$). To accomplish this, the ACE payload includes six high-resolution spectrometers, each designed to provide the optimum charge, mass, or charge-state resolution in its particular energy range, and each having a geometry factor optimized for the expected flux levels, so as to provide a collecting power a factor of 10 to 1000 times greater than previous or planned experiments. The payload also includes several instruments of standard design that will monitor solar wind and magnetic field conditions and energetic H, He, and electron fluxes. We summarize here the scientific objectives, instrumentation, spacecraft, and mission approach that were defined for ACE during the Phase-A study period. 4 refs., 4 figs., 2 tabs.

20531 (N–90-12298) **The behavior of beams of relativistic non-thermal electrons under the influence of collisions and synchrotron losses.** Mctiernan, J.M.; Petrosian, V. Stanford Univ., CA (USA). Nov 1989. 59p. (NASA-CR–185983;NAS–1.26:185983). Available from NTIS, PC A04/MF A01.

For many astrophysical situations, such as in solar flares or cosmic gamma-ray bursts, continuum gamma rays with energies up to hundreds of MeV were observed, and can be interpreted to be due to bremsstrahlung radiation by relativistic electrons. The region of acceleration for these particles is not necessarily the same as the region in which the radiation is produced, and the effects of the transport of the electrons must be included in the general problem. Hence it is necessary to solve the kinetic equation for relativistic electrons, including all the interactions and loss mechanisms relevant at such energies. The resulting kinetic equation for nonthermal electrons, including the effects of Coulomb collisions and losses due to synchrotron emission, was solved analytically in some simple limiting cases, and numerically for the general cases including constant and varying background plasma density and magnetic field. New approximate analytic solutions are presented for collision dominated cases, for small pitch angles and all energies, synchrotron dominated cases, both steady-state and time dependent, for all pitch angles and energies, and for cases when both synchrotron and collisional energy losses are important, but for relativistic electrons. These analytic solutions are compared to the full numerical results in the proper limits. These results will be useful for calculation of spectra and angular distribution of the radiation (x rays, gamma-rays, and microwaves) emitted via synchrotron or bremsstrahlung processes by the electrons. These properties and their relevance to observations will be observed in subsequent papers.

20532 (N–90-12423) **Abstracts for the venus geoscience tutorial and venus geologic mapping workshop.** Lunar and Planetary Inst., Houston, TX (USA). 1989. 62p. (NASA-CR–185432;NAS–1.26:185432;LPI-CONTRIB–708;CONF-8906286–: Venus geoscience tutorial and Venus geologic mapping workshop, Flagstaff, AZ (USA), 12-15 Jun 1989). Available from NTIS, PC A04/MF A01.

Abstracts and tutorial are presented from the workshop. Representative titles are: Geology of Southern Guinevere Planitia, Venus, Based on Analyses of Goldstone Radar Data; Tessera Terrain: Characteristics and Models of Origin; Venus Volcanism; Rate Estimates from Laboratory Studies of Sulfur Gas-Solid Reactions; and A Morphologic Study of Venus Ridge Belts.

20533 (N–90-12423, pp. 4-5) **Tessera terrain: Characteristics and models of origin.** Bindschadler, D.L.; Head, J.W. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–185432;NAS–1.26:185432;LPI-CONTRIB–708;CONF-8906286–: Venus geoscience tutorial and Venus geologic mapping workshop, Flagstaff, AZ (USA), 12-15 Jun 1989). In *Abstracts for the Venus Geoscience Tutorial and Venus Geologic Mapping Workshop.* Available from NTIS, PC A04/MF A01.

Tessera terrain consists of complexly deformed regions characterized by sets of ridges and valleys that intersect at angles ranging from orthogonal to oblique, and were first viewed in Venera 15/16 SAR data. Tesserae cover more area (approx. 15 percent of the area north of 30 deg N) than any of the other tectonic units mapped from the Venera data and are strongly concentrated in the region between longitudes 0 deg E and 150 deg E. Tessera terrain is concentrated between a proposed center of crustal extension and divergence in Aphrodite and a region of intense deformation, crustal convergence, and orogenesis in western Ishtar Terra. Thus, the tectonic processes responsible for tesserae are an important part of Venus tectonics. As part of an effort to understand the formation and evolution of this unusual terrain type, the basic characteristics of the tesserae were compared to the predictions made by a number of tectonic models. The basic characteristics of tessera terrain are described and the models and some of their basic predictions are briefly discussed.

20534 (N–90-12423, pp. 6-7) **Divergent plate boundaries and crustal spreading on Venus: Evidence from Aphrodite Terra.** Crumpler, L.S.; Head, J.W. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–185432;NAS–1.26:185432;LPI-CONTRIB–708;CONF-8906286–: Venus geoscience tutorial and Venus geologic mapping workshop, Flagstaff, AZ (USA), 12-15 Jun 1989). In *Abstracts for the Venus Geoscience Tutorial and Venus Geologic Mapping Workshop.* Available from NTIS, PC A04/MF A01.

The modes of lithospheric heat transfer and the tectonic styles may differ between Earth and Venus, depending on how the high surface temperature (700 K = 430 C), dense and opaque atmosphere (approx. 10 MPa = 100 bars), lack of water oceans, and the other known ways in which Venus differs from Earth, influence basic lithospheric processes, thermal gradient, upper mantle temperature, thermal and chemical evolution, and convection. A fundamental question is whether the lithosphere of Venus is horizontally stable, like the other terrestrial planets, or is mobile like that on Earth. The variety of characteristics, their integrated relationships, and their predictable behavior throughout Western Aphrodite Terra are similar to those features known to occur in association with the terrestrial seafloor at spreading centers and divergent plate boundaries. It is concluded that Western Aphrodite Terra represents the site of crustal spreading centers and divergent plate boundaries. The extent of similar characteristics and processes elsewhere on Venus outside of the 13,000 km long Western and Eastern Aphrodite Terra rise is unknown at the

present, but their presence in other areas of the equatorial highlands, suggested from recent analysis, may be tested with forthcoming Magellan data.

20535 (N-90-12423, pp. 8-9) **Venus volcanism: Rate estimates from laboratory studies of sulfur gas-solid reactions.** Ehlers, K.; Fegley, B. Jr.; Prinn, R.G. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR-185432;NAS-1.26:185432;LPI-CONTRIB-708;CONF-8906286-: Venus geoscience tutorial and Venus geologic mapping workshop, Flagstaff, AZ (USA), 12-15 Jun 1989). In *Abstracts for the Venus Geoscience Tutorial and Venus Geologic Mapping Workshop.* Available from NTIS, PC A04/MF A01.

Thermochemical reactions between sulfur-bearing gases in the atmosphere of Venus and calcium-, iron-, magnesium-, and sulfur-bearing minerals on the surface of Venus are an integral part of a hypothesized cycle of thermochemical and photochemical reactions responsible for the maintenance of the global sulfuric acid cloud cover on Venus. SO2 is continually removed from the Venus atmosphere by reaction with calcium bearing minerals on the planet's surface. The rate of volcanism required to balance SO2 depletion by reactions with calcium bearing minerals on the Venus surface can therefore be deduced from a knowledge of the relevant gas-solid reaction rates combined with reasonable assumptions about the sulfur content of the erupted material (gas + magma). A laboratory program was carried out to measure the rates of reaction between SO2 and possible crustal minerals on Venus. The reaction of CaCO3(calcite) + SO2 yields CaSO4 (anhydrite) + CO was studied. Brief results are given.

20536 (N-90-12423, pp. 10) **Potential for observing and discriminating impact craters and comparable volcanic landforms on Magellan radar images.** Ford, J.P. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR-185432;NAS-1.26:185432;LPI-CONTRIB-708;CONF-8906286-: Venus geoscience tutorial and Venus geologic mapping workshop, Flagstaff, AZ (USA), 12-15 Jun 1989). In *Abstracts for the Venus Geoscience Tutorial and Venus Geologic Mapping Workshop.* Available from NTIS, PC A04/MF A01.

Observations of small terrestrial craters by Seasat synthetic aperture radar (SAR) at high resolution (approx. 25 m) and of comparatively large Venusian craters by Venera 15/16 images at low resolution (1000 to 2000 m) and shorter wavelength show similarities in the radar responses to crater morphology. At low incidence angles, the responses are dominated by large scale slope effects on the order of meters; consequently it is difficult to locate the precise position of crater rims on the images. Abrupt contrasts in radar response to changing slope (hence incidence angle) across a crater produce sharp tonal boundaries normal to the illumination. Crater morphology that is radially symmetrical appears on images to have bilateral symmetry parallel to the illumination vector. Craters are compressed in the distal sector and drawn out in the proximal sector. At higher incidence angles obtained with the viewing geometry of SIR-A, crater morphology appears less compressed on the images. At any radar incidence angle, the distortion of a crater outline is minimal across the medial sector, in a direction normal to the illumination. Radar bright halos surround some craters imaged by SIR-A and Venera 15 and 16. The brightness probably denotes the radar response to small scale surface roughness of the surrounding ejecta blankets. Similarities in the radar responses of small terrestrial impact craters and volcanic craters of comparable dimensions emphasize the difficulties in discriminating an impact origin from a volcanic origin in the images. Similar difficulties will probably apply in discriminating the origin of small Venusian craters, if they exist. Because of orbital considerations, the nominal incidence angel of Magellan radar at the center of the imaging swath will vary from about 45 deg at 10 deg N latitude to about 16 deg at the north pole and at 70 deg S latitude. Impact craters and comparable volcanic landforms will show bilateral symmetry.

20537 (N-90-12423, pp. 11) **Contrasting landform perception with varied radar illumination geometries and at simulated resolutions of Venera and Magellan.** Ford, J.P. (Washington Univ., Saint Louis, MO (USA)); Arvidson, R.E. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR-185432;NAS-1.26:185432;LPI-CONTRIB-708;CONF-8906286-: Venus geoscience tutorial and Venus geologic mapping workshop, Flagstaff, AZ (USA), 12-15 Jun 1989). In *Abstracts for the Venus Geoscience Tutorial and Venus Geologic Mapping Workshop.* Available from NTIS, PC A04/MF A01.

The high sensitivity of imaging radars to slope at moderate to low incidence angles enhances the perception of linear topography on images. It reveals broad spatial patterns that are essential to landform mapping and interpretation. As radar responses are strongly directional, the ability to discriminate linear features on images varies with their orientation. Landforms that appear prominent on images where they are transverse to the illumination may be obscure to indistinguishable on images where they are parallel to it. Landform detection is also influenced by the spatial resolution in radar images. Seasat radar images of the Gran Desierto Dunes complex, Sonora, Mexico; the Appalachian Valley and Ridge Province; and accreted terranes in eastern interior Alaska were processed to simulate both Venera 15 and 16 images (1000 to 3000 km resolution) and image data expected from the Magellan mission (120 to 300 m resolution). The Gran Desierto Dunes are not discernable in the Venera simulation, whereas the higher resolution Magellan simulation shows dominant dune patterns produced from differential erosion of the rocks. The Magellan simulation also shows that fluvial processes have dominated erosion and exposure of the folds.

20538 (N-90-12423, pp. 15-16) **Evidence for volcanism in NW Ishtar Terra, Venus.** Gaddis, L.; Greeley, R. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR-185432;NAS-1.26:185432;LPI-CONTRIB-708;CONF-8906286-: Venus geoscience tutorial and Venus geologic mapping workshop, Flagstaff, AZ (USA), 12-15 Jun 1989). In *Abstracts for the Venus Geoscience Tutorial and Venus Geologic Mapping Workshop.* Available from NTIS, PC A04/MF A01.

Venera 15/16 radar data for an area in NW Ishtar Terra, Venus, show an area with moderate radar return and a smooth textured surface which embays low lying areas of the surrounding mountainous terrain. Although this unit may be an extension of the lava plains of Lakshmi Planum to the southeast, detailed study suggests a separate volcanic center in NW Ishtar Terra. Lakshmi Planum, on the Ishtar Terra highland, exhibits major volcanic and tectonic features. On the Venera radar image radar brightness is influenced by slope and roughness; radar-facing slopes (east-facing) and rough surfaces (approx. 8 cm average relief) are bright, while west-facing slopes and smooth surfaces are dark. A series of semi-circular features, apparently topographic depressions, do not conform in orientation to major structural trends in this region of NW Ishtar Terra. The large depression in NW Ishtar Terra is similar to the calderas of Colette and Sacajawea Paterae, as all three structures are large irregular depressions. NW Ishtar Terra appears to be the site of a volcanic center with a complex caldera structure, possibly more than one eruptive vent, and associated lobed flows at lower elevations. The morphologic similarity between this volcanic center and those of Colette and Sacajawea suggests that centralized eruptions have been the dominant form of volcanism in Ishtar. The location of this volcanic center at the intersection of two major compressional mountain belts and the large size of the calders (with an inferred larg/deep magma source) support a crustal thickening/melting rather than a hot-spot origin for these magmas.

20539 (N-90-12423, pp. 21-22) **Aeolian processes on Venus.** Greeley, R. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR-185432;NAS-1.26:185432;LPI-CONTRIB-708;CONF-8906286-: Venus geoscience tutorial and Venus geologic mapping workshop, Flagstaff, AZ (USA), 12-15 Jun 1989). In *Abstracts for the Venus Geoscience Tutorial and Venus Geologic Mapping Workshop.* Available from NTIS, PC A04/MF A01.

This review assesses the potential aeolian regime on Venus as derived from spacecraft observations, laboratory simulations, and theoretical considerations. The two requirements for aeolian processes (a supply of small, loose particles and winds of sufficient strength to move them) appear to be met on Venus. Venera 9, 10, 13, and 14 images show particles considered to be sand and silt size on the surface. In addition, dust spurts (grains 5 to 50 microns

in diameter) observed via lander images and inferred from the Pioneer-Venus nephalometer experiments suggest that the particles are loose and subject to movement. Although data on near surface winds are limited, measurements of 0.3 to 1.2 m/sec from the Venera lander and Pioneer-Venus probes appear to be well within the range required for sand and dust entrainment. Aeolian activity involves the interaction of the atmosphere, lithosphere, and loose particles. Thus, there is the potential for various physical and chemical weathering processes that can effect not only rates of erosion, but changes in the composition of all three components. The Venus Simulator is an apparatus used to simulate weathering under venusian conditions at full pressure (to 112 bars) and temperature (to 800 K). In one series of tests, the physical modifications of windblown particles and rock targets were assessed and it was shown that particles become abraded even when moved by gentle winds. However, little abrasion occurs on the target faces. Thus, compositional signatures for target rocks may be more indicative of the windblown particles than of the bedrock. From these and other considerations, aeolian modifications of the venusian surface may be expected to occur as weathering, erosion, transportation, and deposition of surficial materials. Depending upon global and local wind regimes, there may be distinctive sources and sinks of windblown materials.

20540 (N–90-12423, pp. 27-28) **Clotho Tessera, Venus: A fragment of Fortuna Tessera.** Kozak, R.C.; Schaber, G.G. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–185432;NAS–1.26:185432;LPI-CONTRIB–708;CONF-8906286–: Venus geoscience tutorial and Venus geologic mapping workshop, Flagstaff, AZ (USA), 12-15 Jun 1989). In *Abstracts for the Venus Geoscience Tutorial and Venus Geologic Mapping Workshop.* Available from NTIS, PC A04/MF A01.

Clotho Tessera, adjacent to southeast Lakshmi Planum, may provide additional evidence for lateral crustal motions, and a model for the origin of small tessera fragments. Clotho Tessera and Lakshmi Planum are so noticeably different, and in such close proximity, it is difficult to derive a reasonable model of their formation in situ. Squeezing of material out from beneath Lakshmi has been suggested as an origin for Moira Tessera, which is also adjacent to Lakshmi and 1400 km west of Clotho. However, a logical model of juxtaposition of the two different terrains, originally from points once distant, can be made for Clotho and Lakshmi (and perhaps other small tesserae as well). It is suggested that Clotho Tessera was once part of Fortuna Tessera, but was cut off by a transcurrent fault zone (the DLZ) striking perpendicular to the Sigrun rift and carried westward where it collided with Lakshmi Planum (forming Danu Montes). A gravity anomaly along the southern border of Lakshmi, in the area of Danu Montes, was interpreted as indicating subduction there, providing additional supporting evidence for the collision hypothesis. Diffusion of the DLZ with proximity to Sigrun Fossae may be due to either higher ductility near the postulated Sigrun rift, or to burial by flows away from the rift nearer to Valkyrie Fossae. Other possible examples of migrating tesserae occur elsewhere: small pieces of Ananke Tessera can be fit back together as though they had rifted apart, and the spreading apart of Ananke and Virilis Tesserae has been suggested because of their symmetric locations about the axis of an inferred spreading zone. Other tessera fragments appear to have been isolated by rifting, with little, if any, significant lateral motion (e.g., Meni and Tellus Tesserae, and Thethus and Fortuna Tesserae). The migrating terrain model for Clotho Tessera supports Sukhanov's interpretation of tesseral fragments as rafts of lighter crustal material.

20541 (N–90-12423, pp. 29) **Tectonism on Venus: A review.** Kozak, R.C.; Schaber, G.G. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–185432;NAS–1.26:185432;LPI-CONTRIB–708;CONF-8906286–: Venus geoscience tutorial and Venus geologic mapping workshop, Flagstaff, AZ (USA), 12-15 Jun 1989). In *Abstracts for the Venus Geoscience Tutorial and Venus Geologic Mapping Workshop.* Available from NTIS, PC A04/MF A01.

Venus is more similar to Earth than to any other planet. It has elevated regions associated with marginal fold and thrust belts, fracture zones that extend tens of thousands of kilometers, crustal swells and shields that are hundreds of kilometers in diameter and 1 to 2 km high, and sublinear accumulations of volcanic cones and domes that stretch for thousands of kilometers across the plains. The Venusian surface is, however, distinctly different from Earth's in that: (1) its elevated terrains cannot be distinguished from its low plains on a hypsometric curve; (2) trenches have not been found plainsward of the marginal belts; (3) fracture zones bear no resemblance to mid-oceanic ridges; and (4) some features, such as the ridge-belt zone near 210 deg E, seem to have no terrestrial analog. Various theories about tectonism on Venus and Earth of other authors are reviewed.

20542 (N–90-12423, pp. 33-34) **Venus: Mantle convection, hotspots, and tectonics.** Phillips, R.J. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–185432;NAS–1.26:185432;LPI-CONTRIB–708;CONF-8906286–: Venus geoscience tutorial and Venus geologic mapping workshop, Flagstaff, AZ (USA), 12-15 Jun 1989). In *Abstracts for the Venus Geoscience Tutorial and Venus Geologic Mapping Workshop.* Available from NTIS, PC A04/MF A01.

The putative paradigm that planets of the same size and mass have the same tectonic style led to the adaptation of the mechanisms of terrestrial plate tectonics as the a priori model of the way Venus should behave. Data acquired over the last decade by Pioneer Venus, Venera, and ground-based radar have modified this view sharply and have illuminated the lack of detailed understanding of the plate tectonic mechanism. For reference, terrestrial mechanisms are briefly reviewed. Venusian lithospheric divergence, hotspot model, and horizontal deformation theories are proposed and examined.

20543 (N–90-12423, pp. 37-38) **Lakshmi Planum: A distinctive highland volcanic province.** Roberts, K.M.; Head, J.W. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–185432;NAS–1.26:185432;LPI-CONTRIB–708;CONF-8906286–: Venus geoscience tutorial and Venus geologic mapping workshop, Flagstaff, AZ (USA), 12-15 Jun 1989). In *Abstracts for the Venus Geoscience Tutorial and Venus Geologic Mapping Workshop.* Available from NTIS, PC A04/MF A01.

Lakshmi Planum, a broad smooth plain located in western Ishtar Terra and containing two large oval depressions (Colette and Sacajawea), has been interpreted as a highland plain of volcanic origin. Lakshmi is situated 3 to 5 km above the mean planetary radius and is surrounded on all sides by bands of mountains interpreted to be of compressional tectonic origin. Four primary characteristics distinguish Lakshmi from other volcanic regions known on the planet, such as Beta Regio: (1) high altitude, (2) plateau-like nature, (3) the presence of very large, low volcanic constructs with distinctive central calderas, and (4) its compressional tectonic surroundings. Building on the previous work of Pronin, the objective is to establish the detailed nature of the volcanic deposits on Lakshmi, interpret eruption styles and conditions, sketch out an eruption history, and determine the relationship between volcanism and the tectonic environment of the region.

20544 (N–90-12423, pp. 39-40) **Volcanism on Venus: Large shields and major accumulations of small domes.** Schaber, G.G.; Kozak, R.C. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–185432;NAS–1.26:185432;LPI-CONTRIB–708;CONF-8906286–: Venus geoscience tutorial and Venus geologic mapping workshop, Flagstaff, AZ (USA), 12-15 Jun 1989). In *Abstracts for the Venus Geoscience Tutorial and Venus Geologic Mapping Workshop.* Available from NTIS, PC A04/MF A01.

The outer layers of the Venusian lithosphere appear to dissipate heat from the interior through mantle-driven thermal anomalies (hot spots, swells). As a result, Venus exhibits diverse forms of thin-skin tectonism and magmatic transfer to and extrusion from countless numbers of volcanic centers (e.g., shields, paterae, domes) and volcano-tectonic complexes (e.g., coronae, arachnoids). What is known about the distribution and morphologies of major Venusian shields is summarized, and the evidence for possible structural control of major accumulations as long as 5000 km of small volcanic domes is described.

20545 (N–90-12423, pp. 43-44) **Geology of the Venus equatorial region from Pioneer Venus radar imaging.** Senske, D.A.; Head, J.W. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–185432;NAS–1.26:185432;LPI-CONTRIB–708;CONF-8906286–: Venus geoscience tutorial and Venus geologic mapping workshop, Flagstaff, AZ (USA), 12-15 Jun 1989). In *Abstracts for the Venus Geoscience Tutorial and Venus Geologic Mapping Workshop.* Available from NTIS, PC A04/MF A01.

The surface characteristics and morphology of the equatorial region of Venus were first described by Masursky et al. who showed this part of the planet to be characterized by two topographic provinces, rolling plains and highlands, and more recently by Schaber who described and interpreted tectonic zones in the highlands. Using Pioneer Venus (PV) radar image data (15 deg S to 45 deg N), Senske and Head examined the distribution, characteristics, and deposits of individual volcanic features in the equatorial region, and in addition classified major equatorial physiographic and tectonic units on the basis of morphology, topographic signature, and radar properties derived from the PV data. Included in this classification are: plains (undivided), inter-highland tectonic zones, tectonically segmented linear highlands, upland rises, tectonic junctions, dark halo plains, and upland plateaus. In addition to the physiographic units, features interpreted as coronae and volcanic mountains have also been mapped. The latter four of the physiographic units along with features interpreted to be coronae.

20546 (N–90-12423, pp. 46) **Venus and the Archean Earth: Thermal considerations.** Sleep, N.H. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–185432;NAS–1.26:185432;LPI-CONTRIB–708;CONF-8906286–: Venus geoscience tutorial and Venus geologic mapping workshop, Flagstaff, AZ (USA), 12-15 Jun 1989). In *Abstracts for the Venus Geoscience Tutorial and Venus Geologic Mapping Workshop.* Available from NTIS, PC A04/MF A01.

The Archean Era of the Earth is not a direct analog of the present tectonics of Venus. In this regard, it is useful to review the state of the Archean Earth. Most significantly, the temperature of the adiabatic interior of the Earth was 200 to 300 C hotter than the current temperature. Preservation biases limit what can be learned from the Archean record. Archean oceanic crust, most of the planetary surface at any one time, has been nearly all subducted. More speculatively, the core of the Earth has probably cooled more slowly than the mantle. Thus the temperature contrast above the core-mantle boundary and the vigor of mantle plumes has increased with time on the Earth. The most obvious difference between Venus and the present Earth is the high surface temperature and hence a low effective viscosity of the lithosphere. In addition, the temperature contrast between the adiabatic interior and the surface, which drives convection, is less on Venus than on the Earth. It appears that the hot lithosphere enhanced tectonics on the early Venus significantly enough that its interior cooled faster than the Earth's. The best evidence for a cool interior of Venus comes from long wavelength gravity anomalies. The low interior temperatures retard seafloor spreading on Venus. The high surface temperatures on Venus enhance crustal deformation. That is, the lower crust may become ductile enough to permit significant flow between the upper crust and the mantle. There is thus some analogy to modern and ancient areas of high heat flow on the Earth. Archean crustal blocks typically remained stable for long intervals and thus overall are not good analogies to the deformation style on Venus.

20547 (N–90-12423, pp. 47-48) **Coronae on Venus observations and models of origin.** Stofan, E.R. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–185432;NAS–1.26:185432;LPI-CONTRIB–708;CONF-8906286–: Venus geoscience tutorial and Venus geologic mapping workshop, Flagstaff, AZ (USA), 12-15 Jun 1989). In *Abstracts for the Venus Geoscience Tutorial and Venus Geologic Mapping Workshop.* Available from NTIS, PC A04/MF A01.

The Venera 15/16 spacecraft revealed a number of features of unknown origin including coronae, elongate to circular structures with a complex interior surrounded by an annulus of concentric ridges. Eighteen coronae were identified in Venera 15/16 data of Venus; an additional thirteen possible coronae are found in Pioneer Venus and Arecibo data. Coronae, with maximum widths of 160 to over 650 km, are found primarily in two clusters in the Northern Hemisphere located to the east and west of Ishtar Terra. Another possible cluster is located in Themis Regio in the Southern Hemisphere. The majority of coronae are at least partially raised less than 1.5 km above the surrounding region, and over half are partially surrounded by a peripheral trough. A sequence of events for coronae has been determined through mapping. Prior to corona formation, regional compression or extension creates bands of lineaments along which coronae tend to later form. During the early stages of corona formation, relatively raised topography is produced by uplift and volcanic construction. The evolution of coronae and their general characteristics have been compared to two models of corona origin: hotspots and sinking mantle diapirs. In the hotspot or rising mantle diapir model, heating and melting at depth create uplift at the surface. Uplift is accompanied by central extension, facilitating volcanism. Gravitational relaxation of the uplifted region follows producing the compressional features within the annulus and the peripheral trough. Both models can predict the major characteristics and evolutionary sequence of coronae. The sinking diapir model does predict an early-time low and central compression as well as broadening and shallowing of the peripheral trough with time, all of which are not observed at current data resolution.

20548 (N–90-12423, pp. 50-51) **Eastern Ishtar Terra: Tectonic evolution derived from recognized features.** Vorderbruegge, R.W.; Head, J.W. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–185432;NAS–1.26:185432;LPI-CONTRIB–708;CONF-8906286–: Venus geoscience tutorial and Venus geologic mapping workshop, Flagstaff, AZ (USA), 12-15 Jun 1989). In *Abstracts for the Venus Geoscience Tutorial and Venus Geologic Mapping Workshop.* Available from NTIS, PC A04/MF A01.

Previous analyses have recognized several styles and orientations of compressional deformation, crustal convergence, and crustal thickening in Eastern Ishtar Terra. An east to west sense of crustal convergence through small scale folding, thrusting, and buckling is reflected in the high topography and ridge-and-valley morphology of Maxwell Montes and the adjacent portion of Fortuna Tessera. This east to west convergence was accompanied by up to 1000 km of lateral motion and large scale strike-slip faulting within two converging shear zones which has resulted in the present morphology of Maxwell Montes. A more northeast to southwest sense of convergence through large scale buckling and imbrication is reflected in large, northwest-trending scarps along the entire northern boundary of Ishtar Terra, with up to 2 km of relief present at many of the scarps. It was previously suggested that both styles of compression have occurred at the expense of pre-existing tessera regions which have then been overprinted by the latest convergence event. The difference in style is attributed mostly to differences in the properties of the crust converging with the tessera blocks. If one, presumably thick, tessera block converges with another tessera region, then the widespread, distributed style of deformation occurs, as observed in western Fortuna Tessera. However, if relatively thin crust such as suggested for the North Polar Plains converges with thicker tessera regions, then localized deformation occurs, as reflected in the scarps along Northern Ishtar Terra. The purpose is to identify the types of features observed in Eastern Ishtar Terra. Their potential temporal and spatial relationships, is described, possible origins for them is suggested, and how the interpretation of some of these features has led to the multiple-style tectonic evolution model described is shown.

20549 (N–90-12423, pp. 52-53) **Stress distribution and topography of Tellus Regio, Venus.** Williams, D.R.; Greeley, R. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–185432;NAS–1.26:185432;LPI-CONTRIB–708;CONF-8906286–: Venus geoscience tutorial and Venus geologic mapping workshop, Flagstaff, AZ (USA), 12-15 Jun 1989). In *Abstracts for the Venus Geoscience Tutorial and Venus Geologic Mapping Workshop.* Available from NTIS, PC A04/MF A01.

The Tellus Regio area of Venus represents a subset of a narrow latitude band where Pioneer Venus Orbiter (PVO) altimetry data, line-of-sight (LOS) gravity data, and Venera 15/16 radar images

have all been obtained with good resolution. Tellus Regio also has a wide variety of surface morphologic features, elevations ranging up to 2.5 km, and a relatively low LOS gravity anomaly. This area was therefore chosen in order to examine the theoretical stress distributions resulting from various models of compensation of the observed topography. These surface stress distributions are then compared with the surface morphology revealed in the Venera 15/16 radar images. Conclusions drawn from these comparisons will enable constraints to be put on various tectonic parameters relevant to Tellus Regio. The stress distribution is calculated as a function of the topography, the equipotential anomaly, and the assumed model parameters. The topography data is obtained from the PVO altimetry. The equipotential anomaly is estimated from the PVO LOS gravity data. The PVO LOS gravity represents the spacecraft accelerations due to mass anomalies within the planet. These accelerations are measured at various altitudes and angles to the local vertical and therefore do not lend themselves to a straightforward conversion. A minimum variance estimator of the LOS gravity data is calculated, taking into account the various spacecraft altitudes and LOS angles and using the measured PVO topography as an a priori constraint. This results in an estimated equivalent surface mass distribution, from which the equipotential anomaly is determined.

20550 (N–90-12423, pp. 1) **Geology of Southern Guinevere Planitia, Venus, based on analyses of Goldstone radar data.** Arvidson, R.E. (Jet Propulsion Lab., Pasadena (USA)); Plaut, J.J.; Jurgens, R.F.; Saunders, R.S.; Slade, M.A. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–185432;NAS–1.26:185432;LPI-CONTRIB–708;CONF-8906286–: Venus geoscience tutorial and Venus geologic mapping workshop, Flagstaff, AZ (USA), 12-15 Jun 1989). In *Abstracts for the venus geoscience tutorial and venus geologic mapping workshop.* Available from NTIS, PC A04/MF A01.

The ensemble of 41 backscatter images of Venus acquired by the S Band (12.6 cm) Goldstone radar system covers approx. 35 million km and includes the equatorial portion of Guinevere Planitia, Navka Planitia, Heng-O Chasma, and Tinatin Planitia, and parts of Devana Chasma and Phoebe Regio. The images and associated altimetry data combine relatively high spatial resolution (1 to 10 km) with small incidence angles (less than 10 deg) for regions not covered by either Venera Orbiter or Arecibo radar data. Systematic analyses of the Goldstone data show that: (1) Volcanic plains dominate, including groups of small volcanic constructs, radar bright flows on a NW-SE arm of Phoebe Regio and on Ushas Mons and circular volcano-tectonic depressions; (2) Some of the regions imaged by Goldstone have high radar cross sections, including the flows on Ushas Mons and the NW-SE arm of Phoebe Regio, and several other unnamed hills, ridged terrains, and plains areas; (3) A 1000 km diameter multiringed structure is observed and appears to have a morphology not observed in Venera data (The northern section corresponds to Heng-O Chasma); (4) A 150 km wide, 2 km deep, 1400 km long rift valley with upturned flanks is located on the western flank of Phoebe Regio and extends into Devana Chasma; (5) A number of structures can be discerned in the Goldstone data, mainly trending NW-SE and NE-SW, directions similar to those discerned in Pioneer-Venus topography throughout the equatorial region; and (6) The abundance of circular and impact features is similar to the plains global average defined from Venera and Arecibo data, implying that the terrain imaged by Goldstone has typical crater retention ages, measured in hundreds of millions of years. The rate of resurfacing is less than or equal to 4 km/Ga.

20551 (N–90-12423, pp. 17-18) **Analysis of radar images of the active volcanic zone at Krafla, Iceland: The effects of look azimuth biasing.** Garvin, J.B. (Geological Survey, Reston, VA (USA)); Williams, R.S. Jr. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–185432;NAS–1.26:185432;LPI-CONTRIB–708;CONF-8906286–: Venus geoscience tutorial and Venus geologic mapping workshop, Flagstaff, AZ (USA), 12-15 Jun 1989). In *Abstracts for the Venus Geoscience Tutorial and Venus Geologic Mapping Workshop.* Available from NTIS, PC A04/MF A01.

The geomorphic expression of Mid-Ocean-Ridge (MOR) volcanism in a subaerial setting occurs uniquely on Earth in Iceland, and the most recent MOR eruptive activity has been concentrated in the Northeastern Volcanic Zone in an area known as Krafla. Within the Krafla region are many of the key morphologic elements of MOR-related basaltic volcanism, as well as volcanic explosion craters, subglacial lava shields, tectonic fissure swarms known as gjar, and basaltic-andesite flows with well developed ogives (pressure-ridges). The objective was to quantify the degree to which the basic volcanic and structural features can be mapped from directional SAR imagery as a function of the look azimuth. To accomplish this, the current expression of volcanic and tectonic constructs was independently mapped within the Krafla region on the E, W, and N-looking SAR images, as well as from SPOT Panchromatic imagery acquired in 1987. The initial observations of the E, W, and N images indicates that fresh a'a lava surfaces are extremely radar bright (rough at 3 cm to meter scales) independent of look direction; this suggests that these flows do not have strong flow direction related structures at meter and cm scales, which is consistent with typical Icelandic a'a lava surfaces in general. The basic impression from a preliminary analysis of the effects of look azimuth biasing on interpretation of the geology of an active MOR volcanic zone is that up to 30 percent of the diagnostic features can be missed at any given look direction, but that having two orthogonal look direction images is probably sufficient to prevent gross misinterpretation.

20552 (N–90-12423, pp. 49) **Crustal deformation: Earth vs Venus.** Turcotte, D.L. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–185432;NAS–1.26:185432;LPI-CONTRIB–708;CONF-8906286–: Venus geoscience tutorial and Venus geologic mapping workshop, Flagstaff, AZ (USA), 12-15 Jun 1989). In *Abstracts for the Venus Geoscience Tutorial and Venus Geologic Mapping Workshop.* Available from NTIS, PC A04/MF A01.

It is timely to consider the possible tectonic regimes on Venus both in terms of what is known about Venus and in terms of deformation mechanisms operative on the earth. Plate tectonic phenomena dominate tectonics on the earth. Horizontal displacements are associated with the creation of new crust at ridges and destruction of crust at trenches. The presence of plate tectonics on Venus is debated, but there is certainly no evidence for the trenches associated with subduction on the earth. An essential question is what kind of tectonics can be expected if there is no plate tectonics on Venus. Mars and the Moon are reference examples. Volcanic constructs appear to play a dominant role on Mars but their role on Venus is not clear. On single plate planets and satellites, tectonic structures are often associated with thermal stresses. Cooling of a planet leads to thermal contraction and surface compressive features. Delamination has been propsed for Venus by several authors. Delamination is associated with the subduction of the mantle lithosphere and possibly the lower crust but not the upper crust. The surface manifestations of delamination are unclear. There is some evidence that delamination is occurring beneath the Transverse Ranges in California. Delamination will certainly lead to lithospheric thinning and is likely to lead to uplift and crustal thinning.

20553 (N–90-12458) **The hard x rays and gamma-rays from solar flares.** Mctiernan, J.M.; Petrosian, V. Stanford Univ., CA (USA). Nov 1989. 35p. (NASA-CR–185982;NAS–1.26:185982). Available from NTIS, PC A03/MF A01.

Radiation of energies from 10 KeV to greater than 10 MeV has been observed during solar flares, and is interpreted to be due to bremsstrahlung by relativistic electrons. A complete treatment of this problem requires solution of the kinetic equation for relativistic electrons and inclusion of synchrotron energy losses. Using the electron distributions obtained from numerical solutions of this equation the bremsstrahlung spectra in the impulsive x ray and gamma-ray regimes are calculated, and the variation of these spectral indices and directivities with energy and observation angle are described. The dependences of these characteristics of the radiation of changes in the solar atmospheric model, including the convergence of the magnetic field, the injected electron spectral index, and most importantly, in the anisotropy of the injected electrons and of the convergence of the magnetic field are also

described. The model results are compared with stereoscopic observations of individual flares and the constraints that this data sets on the models are discussed.

20554 (N–90-12459) **Max '91 Workshop 2: Developments in Observations and Theory for Solar Cycle 22.** Winglee, R.M.; Dennis, B.R. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. 1989. 377p. (NASA-TM–101893;NAS–1.15:101893;CONF-8906287–: Max '91 workshop 2: developments in observations and theory for solar cycle 22, Laurel, MD (USA), 8-9 Jun 1989). Available from NTIS, PC A17/MF A03.

Papers and observatory reports presented at the second workshop of the Max '91 program are compiled along with discussion group summaries and invited reviews. The four discussion groups addressed the following subjects: high-energy flare physics; coordinated magnetograph observations; flare theory and modeling; and Max '91 communications and coordination. A special session also took place on observations of Active Region 5395 and the associated flares of March 1989. Other topics covered during the workshop include the scientific objectives of solar gamma ray observations, the solar capabilities of each of the four instruments on the Gamma Ray Observatory, and access to Max '91 information.

20555 (N–90-12459, pp. 1-16) **High energy flare physics group summary.** Ryan, J.M. (Naval Research Lab., Washington, DC (USA)); Kurfess, J.D. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. 1989. (NASA-TM–101893;NAS–1.15:101893;CONF-8906287–: Max '91 workshop 2: developments in observations and theory for solar cycle 22, Laurel, MD (USA), 8-9 Jun 1989). In *Max '91 Workshop 2: Developments in Observations and Theory for Solar Cycle 22.* Available from NTIS, PC A17/MF A03.

The contributions of the High Energy Flare Physics Special Session in the American Astronomical Society Solar Physics Division Meeting are reviewed. Oral and poster papers were presented on observatories and instruments available for the upcoming solar maximum. Among these are the space-based Gamma Ray Observatory, the Solar Flare and Cosmic Burst Gamma Ray Experiment on the Ulysses spacecraft, the Soft X Ray Telescope on the spacecraft Solar-A, and the balloon-based Gamma Ray Imaging Device. Ground based observatories with new capabilities include the BIMA mm-wave interferometer (Univ. of California, Berkeley; Univ. of Illinois; Univ. of Maryland), Owens Valley Radio Observatory and the Very Large Array. The highlights of the various instrument performances are reported and potential data correlations and collaborations are suggested.

20556 (N–90-12459, pp. 17-26) **Magnetograph group summary.** Jones, H.P. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. 1989. (NASA-TM–101893;NAS–1.15:101893;CONF-8906287–: Max '91 workshop 2: developments in observations and theory for solar cycle 22, Laurel, MD (USA), 8-9 Jun 1989). In *Max '91 Workshop 2: Developments in Observations and Theory for Solar Cycle 22.* Available from NTIS, PC A17/MF A03.

The Magnetograph Group focussed on the techniques and many practical problems of interleaving ground-based measurements of magnetic fields from diverse sites and instruments to address the original scientific objectives. The predominant view of the discussion group was that present instrumentation and analysis resources do not warrant immediate, specific plans for further worldwide campaigns of cooperative magnetograph observing. The several reasons for this view, together with many caveats, qualifications, and suggestions for future work are presented.

20557 (N–90-12459, pp. 27-30) **Theory and modeling group.** Holman, G.D. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. 1989. (NASA-TM–101893;NAS–1.15:101893;CONF-8906287–: Max '91 workshop 2: developments in observations and theory for solar cycle 22, Laurel, MD (USA), 8-9 Jun 1989). In *Max '91 Workshop 2: Developments in Observations and Theory for Solar Cycle 22.* Available from NTIS, PC A17/MF A03.

The primary purpose of the Theory and Modeling Group meeting was to identify scientists engaged or interested in theoretical work pertinent to the Max '91 program, and to encourage theorists to pursue modeling which is directly relevant to data which can be expected to result from the program. A list of participants and their institutions is presented. Two solar flare paradigms were discussed during the meeting – the importance of magnetic reconnection in flares and the applicability of numerical simulation results to solar flare studies.

20558 (N–90-12459, pp. 33-34) **Scientific objectives of solar gamma-ray observations.** Lingenfelter, R.E. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. 1989. (NASA-TM–101893;NAS–1.15:101893;CONF-8906287–: Max '91 workshop 2: developments in observations and theory for solar cycle 22, Laurel, MD (USA), 8-9 Jun 1989). In *Max '91 Workshop 2: Developments in Observations and Theory for Solar Cycle 22.* Available from NTIS, PC A17/MF A03.

Solar flare neutrons and gamma rays are produced by nuclear interactions of flare accelerated ions in the solar atmosphere. A rich variety of such gamma ray and neutron observations have been made by the Solar Maximum Mission (SSM), other satellite, balloon and ground based detectors, and they have provided a wealth of unique information on the nature of particle acceleration in flares and on the flare process itself. What we have learned from these observations is briefly reviewed, and what we can hope to learn from more sensitive new observations to be made with the Gamma Ray Observatory (GRO), the Max '91 balloon program, and the Nuclear Astrophysics Explorer is outlined.

20559 (N–90-12459, pp. 35-45) **The Gamma-Ray Observatory: An overview.** Kniffen, D.A. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. 1989. (NASA-TM–101893;NAS–1.15:101893;CONF-8906287–: Max '91 workshop 2: developments in observations and theory for solar cycle 22, Laurel, MD (USA), 8-9 Jun 1989). In *Max '91 Workshop 2: Developments in Observations and Theory for Solar Cycle 22.* Available from NTIS, PC A17/MF A03.

The Gamma-Ray Observatory (GRO) is a 16,000 kg spacecraft containing four instruments which span almost six decades of energy from about 50 keV to about 30 GeV. It will provide the first opportunity to make simultaneous observations over such a broad band of gamma-ray energies. GRO is assembled and undergoing testing prior to its scheduled June 4, 1990 launch aboard the Space Shuttle. The orbit will be circular with an altitude of 450 km and with an inclination of 28 degrees. Data will be recorded at 32 kilobits per second and dumped once per orbit via the Tracking and Data Relay Satellite System (TDRSS). The spacecraft is three-axis stabilized and timing will be maintained to .1 ms. The observing schedule will begin with an all sky survey, consisting of 30 two week pointings, covering the first 15 months of science operations. Following observations will emphasize source studies and deep searches. Originally selected as a Principal Class spacecraft with a two year mission, extension of the mission to six to ten years makes a vigorous Guest Investigator Program both possible and desirable. Such a program will be fully in place by the third year of the mission, with limited opportunities earlier. Each of the four instruments has a capability for observing both gamma-ray bursts and solar flare gamma-rays, and there is some solar neutron capability. Correlated observations with those at other wavelengths is also receiving considerable attention in the mission planning.

20560 (N–90-12459, pp. 46-59) **When and where to look to observe major solar flares.** Bai, T. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. 1989. (NASA-TM–101893;NAS–1.15:101893;CONF-8906287–: Max '91 workshop 2: developments in observations and theory for solar cycle 22, Laurel, MD (USA), 8-9 Jun 1989). In *Max '91 Workshop 2: Developments in Observations and Theory for Solar Cycle 22.* Available from NTIS, PC A17/MF A03.

When and where to look is an important issue to observers planning to observe major solar flares. Prediction of major flares is also important because they influence the Earth's environment. Techniques for utilizing recently discovered solar hot spots and a solar activity periodicity of about 154 days in determining when and where to look to catch major flares are discussed.

20561 (N–90-12459, pp. 65-74) **Capabilities of GRO/OSSE for observing solar flares.** Kurfess, J.D. (Universities Space Research Association, Columbia, MD (USA)); Johnson, W.N.; Share, G.H.; Hulburt, E.O.; Matz, S.M.; Murphy, R.J. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. 1989. (NASA-TM–101893;NAS–1.15:101893;CONF-8906287–: Max '91 workshop 2: developments in observations and theory for solar cycle 22, Laurel, MD (USA), 8-9 Jun 1989). In *Max '91 Workshop 2: Developments in Observations and Theory for Solar Cycle 22.* Available from NTIS, PC A17/MF A03.

The launch of the Gamma Ray Observatory (GRO) near solar maximum makes solar flare studies early in the mission particularly advantageous. The Oriented Scintillation Spectrometer Experiment (OSSE) on GRO, covering the energy range 0.05 to 150 MeV, has some significant advantages over the previous generation of satellite-borne gamma-ray detectors for solar observations. The OSSE detectors will have about 10 times the effective area of the Gamma-Ray Spectrometer (GRS) on Solar Maximum Mission (SMM) for both photons and high-energy neutrons. The OSSE also has the added capability of distinguishing between high-energy neutrons and photons directly. The OSSE spectral accumulation time (approx. 4s) is four times faster than that of the SMM/GRS; much better time resolution is available in selected energy ranges. These characteristics will allow the investigation of particle acceleration in flares based on the evolution of the continuum and nuclear line components of flare spectra, nuclear emission in small flares, the anisotropy of continuum emission in small flares, and the relative intensities of different nuclear lines. The OSSE observational program will be devoted primarily to non-solar sources. Therefore, solar observations require planning and special configurations. The instrumental and operational characteristics of OSSE are discussed in the context of undertaking solar observations. The opportunities for guest investigators to participate in solar flare studies with OSSE is also presented.

20562 (N–90-12459, pp. 75-95) **The solar gamma ray and neutron capabilities of COMPTEL on the Gamma Ray Observatory.** Ryan, J.M.; Lockwood, J.A. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. 1989. (NASA-TM–101893;NAS–1.15:101893;CONF-8906287–: Max '91 workshop 2: developments in observations and theory for solar cycle 22, Laurel, MD (USA), 8-9 Jun 1989). In *Max '91 Workshop 2: Developments in Observations and Theory for Solar Cycle 22.* Available from NTIS, PC A17/MF A03.

The imaging Compton telescope COMPTEL on the Gamma Ray Observatory (GRO) has unusual spectroscopic capabilities for measuring solar gamma-ray and neutron emission. The launch of the GRO is scheduled for June 1990 near the peak of the sunspot cycle. With a 30 to 40 percent probability for the Sun being in the COMPTEL field-of-view during the sunlit part of an orbit, a large number of flares will be observed above the 800 keV gamma-ray threshold of the telescope. The telescope energy range extends to 30 MeV with high time resolution burst spectra available from 0.1 to 10 MeV. Strong Compton tail suppression of instrumental gamma-ray interactions will facilitate improved spectral analysis of solar flare emissions. In addition, the high signal to noise ratio for neutron detection and measurement will provide new neutron spectroscopic capabilities. Specifically, a flare similar to that of 3 June 1982 will provide spectroscopic data on greater than 1500 individual neutrons, enough to construct an unambiguous spectrum in the energy range of 20 to 200 MeV. Details of the instrument and its response to solar gamma-rays and neutrons will be presented.

20563 (N–90-12459, pp. 96-106) **The BATSE experiment on the Gamma Ray Observatory: Solar flare hard x ray and gamma-ray capabilities.** Fishman, G.J. (California Univ., San Diego (USA)); Meegan, C.A.; Wilson, R.B.; Parnell, T.A.; Paciesas, W.S.; Pendleton, G.N.; Hudson, H.S.; Matteson, J.L.; Peterson, L.E.; Cline, T.L. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. 1989. (NASA-TM–101893;NAS–1.15:101893;CONF-8906287–: Max '91 workshop 2: developments in observations and theory for solar cycle 22, Laurel, MD (USA), 8-9 Jun 1989). In *Max '91 Workshop 2: Developments in Observations and Theory for Solar Cycle 22.* Available from NTIS, PC A17/MF A03.

The Burst and Transient Source Experiment (BATSE) for the Gamma Ray Observatory (GRO) consists of eight detector modules that provide full-sky coverage for gamma-ray bursts and other transient phenomena such as solar flares. Each detector module has a thin, large-area scintillation detector (2025 sq cm) for high time-resolution studies, and a thicker spectroscopy detector (125 sq cm) to extend the energy range and provide better spectral resolution. The total energy range of the system is 15 keV to 100 MeV. These 16 detectors and the associated onboard data system should provide unprecedented capabilities for observing rapid spectral changes and gamma-ray lines from solar flares. The presence of a solar flare can be detected in real-time by BATSE; a trigger signal is sent to two other experiments on the GRO. The launch of the GRO is scheduled for June 1990, so that BATSE can be an important component of the Max '91 campaign.

20564 (N–90-12459, pp. 107-109) **The solar flare and cosmic gamma-ray burst experiment aboard the Ulysses spacecraft.** Boer, M. (California Univ., Berkeley (USA)); Sommer, M.; Hurley, K. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. 1989. (NASA-TM–101893;NAS–1.15:101893;CONF-8906287–: Max '91 workshop 2: developments in observations and theory for solar cycle 22, Laurel, MD (USA), 8-9 Jun 1989). In *Max '91 Workshop 2: Developments in Observations and Theory for Solar Cycle 22.* Available from NTIS, PC A17/MF A03.

The HUS-Ulysses team has prepared an instrument for the Ulysses spacecraft consisting of 2 Csi detectors and 2 Si surface barrier detectors for measuring x rays in the range 5 to 200 keV with up to 8 ms time resolution. The prime objectives of the experiment are the study of solar flares and cosmic gamma-ray bursts. The Ulysses mission will leave the ecliptic during the forthcoming solar maximum. The total time above ecliptic latitudes + or - 70 degrees is expected to be 230 days. The solar data can be used in conjunction with other experiments to measure the directivity of the emission and for correlative studies.

20565 (N–90-12459, pp. 110-118) **VLA-Max '91 tests of high energy flare physics.** Lang, K.R.; Willson, R.F. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. 1989. (NASA-TM–101893;NAS–1.15:101893;CONF-8906287–: Max '91 workshop 2: developments in observations and theory for solar cycle 22, Laurel, MD (USA), 8-9 Jun 1989). In *Max '91 Workshop 2: Developments in Observations and Theory for Solar Cycle 22.* Available from NTIS, PC A17/MF A03.

The potential for the Very Large Array (VLA) contributions during the coming maximum in solar activity is illustrated by unpublished observations of solar flares on 28 May, 8 June, 24 June, and 30 September 1988. Some of this data appears in the two papers by Willson et al., referenced in this article. The VLA can be used to spatially resolve flaring active regions and their magnetic fields. These results can be compared with simultaneous x ray and gamma ray observations from space. Examples are provided in which spatially separated radio sources are resolved for the preburst, impulsive and decay phases of solar flares. The emergence of precursor coronal loops probably triggers the release of stored magnetic energy in adjacent coronal loops. Noise storm enhancements can originate in large-scale coronal loops on opposite sides of the visible solar disk. An interactive feedback mechanism may exist between activity in high-lying 90 cm coronal loops and lower-lying 20 cm ones.

20566 (N–90-12459, pp. 119-130) **First interferometric observations with arc-sec resolution of solar radio bursts at millimeter wavelengths.** Kundu, M.R. (California Univ., Berkeley (USA)); White, S.M.; Gopalswamy, N.; Bieging, J.H. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. 1989. (NASA-TM–101893;NAS–1.15:101893;CONF-8906287–: Max '91 workshop 2: developments in observations and theory for solar cycle 22, Laurel, MD (USA), 8-9 Jun 1989). In *Max '91 Workshop 2: Developments in Observations and Theory for Solar Cycle 22.* Available from NTIS, PC A17/MF A03.

The Berkeley-Maryland-Illinois Array (BIMA) is briefly described in the context of solar observations. Specific areas of research that

could be performed using BIMA during the Solar Maximum Mission (SMM) in 1991 are outlined. Some preliminary results of flare observations during March 1989 are presented.

20567 (N–90-12459, pp. 131-142) **Observational goals for Max '91 to identify the causative agent for impulsive bursts.** Batchelor, D.A. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. 1989. (NASA-TM–101893;NAS–1.15:101893;CONF-8906287–: Max '91 workshop 2: developments in observations and theory for solar cycle 22, Laurel, MD (USA), 8-9 Jun 1989). In *Max '91 Workshop 2: Developments in Observations and Theory for Solar Cycle 22.* Available from NTIS, PC A17/MF A03.

Recent studies of impulsive hard x ray and microwave bursts suggest that a propagating causative agent with a characteristic velocity of the order of 1000 km/s is responsible for these bursts. The results of these studies are summarized and observable distinguishing characteristics of the various possible agents are highlighted, with emphasis on key observational goals for the Max '91 campaigns. The most likely causative agents suggested by the evidence are shocks, thermal conduction fronts, and propagating modes of magnetic reconnection in flare plasmas. With new instrumentation planned for Max '91, high spatial resolution observations of hard x ray sources have the potential to identify the agent by revealing detailed features of source spatial evolution. Observations with the Very Large Array and other radio imaging instruments are of great importance, as well as detailed modeling of coronal loop structures to place limits on their density and temperature profiles. With the combined hard x ray and microwave imaging observations, aided by loop model results, the simplest causative agent to rule out would be the propagating modes of magnetic reconnection. To fit the observational evidence, reconnection modes would need to travel at approximately the same velocity (the Alfven velocity) in different coronal structures that vary in length by a factor of 10(exp 3). Over such a vast range in loop lengths, it is difficult to believe that the Alfven velocity is constant. Thermal conduction fronts would be suggested by sources that expand along the direction of B and exhibit relatively little particle precipitation. Particle acceleration due to shocks could produce more diverse radially expanding source geometries with precipitation at loop footprints.

20568 (N–90-12459, pp. 143-157) **Solar flare gamma-ray and hard x ray imaging with the GRID-on-a-balloon.** Orwig, L.E. (Naval Research Lab., Washington, DC (USA)); Crannell, C.J.; Dennis, B.R.; Starr, R.; Hurford, G.J.; Hudson, H.S.; Vanbeek, F.; Greene, M.E.; Johnson, W.N.; Norris, J.P. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. 1989. (NASA-TM–101893;NAS–1.15:101893;CONF-8906287–: Max '91 workshop 2: developments in observations and theory for solar cycle 22, Laurel, MD (USA), 8-9 Jun 1989). In *Max '91 Workshop 2: Developments in Observations and Theory for Solar Cycle 22.* Available from NTIS, PC A17/MF A03.

A primary scientific objective for solar flare research during the rapidly approaching maximum in solar activity is the imaging of gamma-ray and hard x ray sources of solar flare emissions. These goals will be pursued by the Gamma Ray Imaging Device (GRID) instrument, one of three instruments recently selected for NASA's Max '91 Solar Balloon Program. The GRID instrument is based on the technique of Fourier transform imaging and utilizes scanning modulation grid collimator optics to provide full-Sun imaging with 1.9-arcsecond resolution over the energy range from 20 to 700 keV at time resolutions from 0.1 to 2 s. The GRID telescope will employ 32 subcollimators, each composed of a matched pair of high-Z collimator grids separated by 5.2 meters and a phoswich scintillation spectrometer detector having no spatial resolution. The subcollimators and integrally-mounted fine aspect system are contained within a telescope canister which will be pointed to 0.1 degree accuracy and cyclically scanned to produce source modulation. The 32 subcollimators provide a uniform distribution of grid slit orientations and a logarithmic distribution of slit spacings corresponding to angular dimensions of 1.9 arcseconds to several arcminutes. The instrument is several orders of magnitude more sensitive than the HXIS instrument on the Solar Maximum Mission (SMM) and nearly 10 times more sensitive than any similar instrument scheduled to fly during the next solar maximum. The payload, designed for long-duration high-altitude balloon capability, is scheduled for its first science flight (8 to 14 days duration) from the Antarctic in January of 1992.

20569 (N–90-12459, pp. 158-172) **The soft x ray telescope for Solar-A.** Brown, W.A.; Acton, L.W.; Bruner, M.E.; Lemen, J.R.; Strong, K.T. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. 1989. (NASA-TM–101893;NAS–1.15:101893;CONF-8906287–: Max '91 workshop 2: developments in observations and theory for solar cycle 22, Laurel, MD (USA), 8-9 Jun 1989). In *Max '91 Workshop 2: Developments in Observations and Theory for Solar Cycle 22.* Available from NTIS, PC A17/MF A03.

The Solar-A satellite being prepared by the Institute for Sapce and Astronautical Sciences (ISAS) in Japan is dedicated to high energy observations of solar flares. The Soft X Ray Telescope (SXT) is being prepared to provide filtered images in the 2 to 60 A interval. The flight model is now undergoing tests in the 1000 foot tunnel at MSFC. Launch will be in September 1991. Earlier resolution and efficiency tests on the grazing incidence mirror have established its performance in soft x rays. The one-piece, two mirror grazing incidence telescope is supported in a strain free mount separated from the focal plane assembly by a carbon-epoxy metering tube whose windings and filler are chosen to minimize thermal and hygroscopic effects. The CCD detector images both the x ray and the concentric visible light aspect telescope. Optical filters provide images at 4308 and 4700 A. The SXT will be capable of producing over 8000 of the smallest partial frame images per day, or fewer but larger images, up to 1024 x 1024 pixel images. Image sequence with two or more of the five x ray analysis filters, with automatic exposure compensation to optimize the charge collection by the CCD detector, will be used to provide plasma diagnostics. Calculations using a differential emission measure code were used to optimize filter selection over the range of emission measure variations and to avoid redundancy, but the filters were chosen primarily to give ratios that are monotonic in plasma temperature.

20570 (N–90-12459, pp. 173-182) **Pre-pulses: Signature of a trigger process in short (less than 60 secs) solar hard x ray flares.** Deasi, U.; Orwig, L.E. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. 1989. (NASA-TM–101893;NAS–1.15:101893;CONF-8906287–: Max '91 workshop 2: developments in observations and theory for solar cycle 22, Laurel, MD (USA), 8-9 Jun 1989). In *Max '91 Workshop 2: Developments in Observations and Theory for Solar Cycle 22.* Available from NTIS, PC A17/MF A03.

The continuing study of short hard x ray events (less than 60 sec duration) from the Solar Maximum Mission (SMM) Hard X ray Burst Spectrometer (HXRBS) instrument has revealed a unique feature. A well-separated distinctly identifiable, narrow (2 to 6 sec wide) pulse occurs prior to the start of the longer-flare lasting emission activity. Light curves are presented for eight events showing this feature. The pre-pulses show symmetrical rise and fall times. Spectral evolution of the pre-pulses are presented and their evolution compared to that of the main event spectra. It is argued that this feature be the elementary flare burst (de Jager, 1978). These pre-pulses could be a signature of the magnetic reconnection phenomenon discussed by Sturrock et al., (1984).

20571 (N–90-12459, pp. 198-203) **Joule heating and runaway electron acceleration in a solar flare.** Holman, G.D. (California Univ., Berkeley (USA)); Kundu, M.R.; Kane, S.R. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. 1989. (NASA-TM–101893;NAS–1.15:101893;CONF-8906287–: Max '91 workshop 2: developments in observations and theory for solar cycle 22, Laurel, MD (USA), 8-9 Jun 1989). In *Max '91 Workshop 2: Developments in Observations and Theory for Solar Cycle 22.* Available from NTIS, PC A17/MF A03.

The hard and soft x ray and microwave emissions from a solar flare (May 14, 1980) were analyzed and interpreted in terms of Joule heating and runaway electron acceleration in one or more current sheets. It is found that all three emissions can be generated with sub-Dreicer electric fields. The soft x ray emitting plasma can only be heated by a single current sheet if the resistivity in the sheet is well above the classical, collisional resistivity of 10(exp 7)

K, 10(exp 11)/cu cm plasma. If the hard x ray emission is from thermal electrons, anomalous resistivity or densities exceeding 3 x 10(exp 12)/cu cm are required. If the hard x ray emission is from nonthermal electrons, the emissions can be produced with classical resistivity in the current sheets if the heating rate is approximately 4 times greater than that deduced from the soft x ray data (with a density of 10(exp 10)/cu cm in the soft x ray emitting region), if there are at least 10(exp 4) current sheets, and if the plasma properties in the sheets are characteristic of the superhot plasma observed in some flares by Lin et al., and with Hinotori. Most of the released energy goes directly into bulk heating, rather than accelerated particles.

20572 (N–90-12459, pp. 183-197) **Flare model sensitivity of the Balmer spectrum.** Falchi, A. (Naples Univ. (Italy)); Falciani, R.; Smaldone, L.A.; Tozzi, G.P. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. 1989. (NASA-TM–101893;NAS–1.15:101893;CONF-8906287–: Max '91 workshop 2: developments in observations and theory for solar cycle 22, Laurel, MD (USA), 8-9 Jun 1989). In *Max '91 Workshop 2: Developments in Observations and Theory for Solar Cycle 22.* Available from NTIS, PC A17/MF A03.

Careful studies of various chromospheric spectral signatures are very important in order to explore their possible sensitivity to the modifications of the thermodynamic quantities produced by the flare occurrence. Pioneer work of Canfield and co-workers have shown how the H alpha behavior is able to indicate different changes in the atmospheric parameters structure associated to the flare event. It was decided to study the behavior of the highest Balmer lines and of the Balmer continuum in different solar flare model atmospheres. These spectral features, originating in the deep photosphere in a quiet area, may have a sensitivity different from H alpha to the modification of a flare atmosphere. The details of the method used to compute the Stark profile of the higher Balmer line (n is greater than or equal to 6) and their merging were extensively given elsewhere (Donati-Falchi et al., 1985; Falchi et al., 1989). The models used were developed by Ricchiazzi in his thesis (1982) evaluating the chromospheric response to both the nonthermal electron flux, for energy greater than 20 kev, (F sub 20) and to the thermal conduction, (F sub c). The effect of the coronal pressure values (P sub O) at the apex of the flare loop is also included.

20573 (N–90-12459, pp. 219-228) **Chromospheric-coronal coupling during solar flares: Current systems and particle acceleration.** Winglee, R.M.; Mckean, M.E.; Dulk, G.A. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. 1989. (NASA-TM–101893;NAS–1.15:101893;CONF-8906287–: Max '91 workshop 2: developments in observations and theory for solar cycle 22, Laurel, MD (USA), 8-9 Jun 1989). In *Max '91 Workshop 2: Developments in Observations and Theory for Solar Cycle 22.* Available from NTIS, PC A17/MF A03.

Two-dimensional (three velocity) electrostatic particle simulations are used to investigate the particle heating and acceleration associated with the impulsive phase of a solar flare. A crossfield current in the high corona (which is presumably driven by reconnection processes) is used to initiate the flare. Due to the differential motion of the electrons and ions, currents, and associated quasi-static electric fields are generated with the primary current and balancing return current being on adjacent field lines. These currents extend from the corona down into the chromosphere. Electrons can be accelerated to energies exceeding 100 keV on short time scales via the quasi-static fields and wave-particle interactions. The spectra of these electrons has a broken power-law distribution which hardens in time. The spatially separate primary and return currents are closed by the cross-field acceleration of the ambient ions into the primary current regions. These ions are then accelerated upwards into the corona by the same quasi-static electric field accelerating the electrons downwards. This acceleration can account for the broadened stationary and weak blue shifted component seen in soft x ray line emissions and enhancements in heavy ion abundances seen in the solar wind in associations with solar flares.

20574 (N–90-12459, pp. 233-232) **Development of a numerical solution to the time dependent kinetic equation.** Hamilton, R.J.; Lu, E.T.; Petrosian, V. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. 1989. (NASA-TM–101893;NAS–1.15:101893;CONF-8906287–: Max '91 workshop 2: developments in observations and theory for solar cycle 22, Laurel, MD (USA), 8-9 Jun 1989). In *Max '91 Workshop 2: Developments in Observations and Theory for Solar Cycle 22.* Available from NTIS, PC A17/MF A03.

A numerical solution was developed for the time dependent Fokker-Planck equation for arbitrary distributions of electrons injected into a magnetized plasma. The code which includes energy loss and pitch angle scattering due to Coulomb collisions and changes in pitch angle due to inhomogeneous magnetic fields was calibrated and tested. The numerical method is versatile so that other scattering or radiation terms can be easily included. Using this code many processes associated with the impulsive phase of solar flares will be investigated.

20575 (N–90-12459, pp. 233-241) **Some of the terrestrial effects of AR 5395.** Speich, D. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. 1989. (NASA-TM–101893;NAS–1.15:101893;CONF-8906287–: Max '91 workshop 2: developments in observations and theory for solar cycle 22, Laurel, MD (USA), 8-9 Jun 1989). In *Max '91 Workshop 2: Developments in Observations and Theory for Solar Cycle 22.* Available from NTIS, PC A17/MF A03.

Active Region 5395 was extraordinary for both its flare production for a complete disk transit and for one of the largest geomagnetic storms on record. Some of the more dramatic terrestrial effects resulting from the flare activity are briefly discussed.

20576 (N–90-12459, pp. 242-245) **The 10.7-cm microwave observations of AR 5395 and related terrestrial effects.** Gaizauskas, V.; Hughes, T.J.; Tapping, K.F. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. 1989. (NASA-TM–101893;NAS–1.15:101893;CONF-8906287–: Max '91 workshop 2: developments in observations and theory for solar cycle 22, Laurel, MD (USA), 8-9 Jun 1989). In *Max '91 Workshop 2: Developments in Observations and Theory for Solar Cycle 22.* Available from NTIS, PC A17/MF A03.

The 10.7 cm flux patrols in Canada recorded 4 Great Bursts (peaks greater than 500 sfu) during the disk passage of AR 5395 in March 1989. The Great Bursts of 16 and 17 March were simple events of great amplitude and with half-life durations of only several minutes. Earlier Great Bursts, originating on 6 March towards the NE limb and on 10 March closer to the central meridian, belong to an entirely different category of event. Each started with a very strong impulsive event lasting just minutes. After an initial recovery, however, the emission climbed back to level as greater or greater than the initial impulsive burst. The events of 6 and 10 March stayed above the Great Burst threshold for at least 100 minutes. The second component of long duration in these cases is associated with Type 4 continuum emission and thus very likely with CMEs. Major geomagnetic disturbances did not occur as a result of the massive complex event of 6 March or the two simple but strong events of 16 and 17 March. But some 55 hours after the peak in the long-enduring burst of 10 March, a storm began which qualifies as the fourth strongest geomagnetic storm in Canada since 1932. The vertical component of the earth's field measured during the storm by a fluxgate magnetometer at a station in Manitoba is presented. Within a minute of the sudden commencement of this storm, a series of breakdowns began in the transmission system of Hydro-Quebec which resulted in a total loss of power, on a bitterly cold winter's day, for at least 10 hours. The loss of power provoked an enormous outcry from the public resulting in the power utilities being more receptive to the need to monitor solar as well as geomagnetic activity.

20577 (N–90-12459, pp. 248-258) **The SMM UV observations of Active Region 5395.** Drake, S.A. (ST Systems Corp., Lanham, MD (USA)); Gurman, J.B. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. 1989. (NASA-TM–101893;NAS–1.15:101893;CONF-8906287–: Max '91 workshop 2: developments in observations and theory for solar cycle 22, Laurel, MD (USA), 8-9 Jun 1989). In *Max '91 Workshop 2: Developments in Observations and Theory for Solar Cycle 22.* Available from NTIS, PC A17/MF A03.

The Ultraviolet Spectrometer and Polarimeter (UVSP) on the Solar Maximum Mission (SMM) spacecraft was used extensively to study the spatial morphology and time variability of solar active regions in the far UV (at approx. wavelength of 1370 A) since July 1985. The normal spatial resolution of UVSP observations in this 2nd-order mode is 10 sec., and the highest temporal resolution is 64 milliseconds. To make a full-field, 4 min. by 4 min. image this wavelength using 5 sec. raster steps takes about 3 minutes. UVSP can also make observations of the Sun at approx. wavelength of 2790 with 3 sec. spatial resolution when operated in its 1st-order mode; a full-field image at this wavelength (a so-called SNEW image) takes about 8 minutes. UVSP made thousands of observations (mostly in 2nd-order) of AR 5395 during its transit across the visible solar hemisphere (from 7 to 19 March, inclusive). During this period, UVSP's duty cycle for observing AR 5395 was roughly 40 percent, with the remaining 60 percent of the time being fairly evenly divided between aeronomy studies of the Earth's atmosphere and dead time due to Earth occultation of the Sun. UVSP observed many of the flares tagged to AR 5395, including 26 GOES M-level flares and 3 X-level flares, one of which produced so much UV emission that the safety software of UVSP turned off the detector to avoid damage due to saturation. Images and light curves of some of the more spectacular of the AR 5395 events are presented.

20578 (N–90-12459, pp. 267-275) **Hard x ray highlights of AR 5395.** Schwartz, R.A. (ST Systems Corp., Lanham, MD (USA)); Dennis, B.R. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. 1989. (NASA-TM–101893;NAS–1.15:101893;CONF-8906287–: Max '91 workshop 2: developments in observations and theory for solar cycle 22, Laurel, MD (USA), 8-9 Jun 1989). In *Max '91 Workshop 2: Developments in Observations and Theory for Solar Cycle 22.* Available from NTIS, PC A17/MF A03.

Active Region 5395 produced an exceptional series of hard x ray bursts notable for their frequency, intensity, and impulsivity. Over the two weeks from March 6 to 19, 447 hard x ray flares were observed by the Hard X Ray Burst Spectrometer on Solar Maximum Mission (HXRBS/SMM), a rate of approx. 35 per day which exceeded the previous high by more than 50 percent. During one 5 day stretch, more than 250 flares were detected, also a new high. The three largest GOES X-flares were observed by HXRBS and had hard x ray rates over 100,000 s(exp -1) compared with only ten flares above 100,000(exp -1) during the previous nine years of the mission. An ongoing effort for the HXRBS group has been the correlated analysis of hard x ray data with flare data at other wavelengths with the most recent emphasis on those measurements with spatial information. During a series of bursts from AR 5395 at 1644 to 1648 UT on 12 March 1989, simultaneous observations were made by HXRBS and UVSP (Ultra Violet Spectrometer Polarimeter) on SMM, the two-element Owens Valley Radio Observatory (OVRO) interferometric array, and R. Canfield's H-alpha Echelle spectrograph at the National Solar Observatory at Sacramento Peak. The data show strong correlations in the hard x ray, microwave, and UV lightcurves. This event will be the subject of a combined analysis.

20579 (N–90-12459, pp. 204-218) **Heating and acceleration of coronal and chromospheric ions during solar flares.** McKean, M.E.; Winglee, R.M.; Dulk, G.A. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. 1989. (NASA-TM–101893;NAS–1.15:101893;CONF-8906287–: Max '91 workshop 2: developments in observations and theory for solar cycle 22, Laurel, MD (USA), 8-9 Jun 1989). In *Max '91 Workshop 2: Developments in Observations and Theory for Solar Cycle 22.* Available from NTIS, PC A17/MF A03.

One-dimensional, electrostatic, particle-in-cell simulations are used to explore two mechanisms proposed to explain turbulent broadening of soft x ray emission lines of heavy ions observed during solar flares and the presence of blue-shifted components. Results from the simulations are in qualitative agreement with the observations.

20580 (N–90-12459, pp. 246-247) **Interplanetary energetic particle observations of the March 1989 events.** Sarris, E.T. (Thrace Univ., Xanthe (Greece)); Krimigis, S.M. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. 1989. (NASA-TM–101893;NAS–1.15:101893;CONF-8906287–: Max '91 workshop 2: developments in observations and theory for solar cycle 22, Laurel, MD (USA), 8-9 Jun 1989). In *Max '91 Workshop 2: Developments in Observations and Theory for Solar Cycle 22.* Available from NTIS, PC A17/MF A03.

The IMP-8 spacecraft placed in an elongated orbit of approximately R(sub E) x R(sub E) orbit around the Earth was the only monitor of the energetic particle environment of the near interplanetary space during the period of the solar particle events associated with the Active Region 5395 in March 1989. Measurements of energetic ion and electron intensities were obtained in a series of channels within the energy range: 0.3 to 440 MeV for photons, 0.6 to 52 MeV/nuc for alpha particles, 0.7 to 3.3 MeV/nuc for nuclei with Z greater than or equal to 3, 3 to 9 MeV/nuc with Z greater than or equal to 20, and 0.2 to 2.5 MeV for electrons. The responses of selected energy channels during the period 5 to 23 March 1989 are displayed. It is clearly noted that the most prominent energetic ion intensity enhancements in that time interval were associated with the interplanetary shock wave of March 13 (07:42 UT) as well as that of March 8 (17:56 UT), which have distinct particle acceleration signatures. These shock waves play a major role in determining the near Earth energetic ion intensities during the above period by accelerating and modulating the ambient solar energetic particle population, which was already present in high intensities in the interplanetary medium due to the superposition of a series of solar flare particle events originating in AR 5395. The differential ion intensities at the lowest energy channel of the CPME experiment, which were associated with the March 13 shock wave, reached the highest level in the life of the IMP-8 spacecraft at this energy. At high energies, the shock associated intensity peak was smaller by less than a factor of 3 than the maxima of solar flare particle intensities from some other major flares, in particular from those with sites well connected to the Earth's magnetic flux tubes.

20581 (N–90-12459, pp. 320-323) **The onset of the solar active cycle 22.** Ahluwalia, H.S. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. 1989. (NASA-TM–101893;NAS–1.15:101893;CONF-8906287–: Max '91 workshop 2: developments in observations and theory for solar cycle 22, Laurel, MD (USA), 8-9 Jun 1989). In *Max '91 Workshop 2: Developments in Observations and Theory for Solar Cycle 22.* Available from NTIS, PC A17/MF A03.

There is a great deal of interest in being able to predict the main characteristics of a solar activity cycle (SAC). One would like to know, for instance, how large the amplitude (R sub m) of a cycle is likely to be, i.e., the annual mean of the sunspot numbers at the maximum of SAC. Also, how long a cycle is likely to last, i.e., its period. It would also be interesting to be able to predict the details, like how steep the ascending phase of a cycle is likely to be. Questions like these are of practical importance to NASA in planning the launch schedule for the low altitude, expensive spacecrafts like the Hubble Space Telescope, the Space Station, etc. Also, one has to choose a proper orbit, so that once launched the threat of an atmospheric drag on the spacecraft is properly taken into account. Cosmic ray data seem to indicate that solar activity cycle 22 will surpass SAC 21 in activity. The value of R sub m for SAC 22 may approach that of SAC 19. It would be interesting to see whether this prediction is borne out. Researchers are greatly encouraged to proceed with the development of a comprehensive prediction model which includes information provided by cosmic ray data.

20582 (N–90-12459, pp. 324-327) **An imaging vector magnetograph for the next solar maximum.** Mickey, D.L.; Labonte, B.J.; Canfield, R.C. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. 1989. (NASA-TM–101893;NAS–1.15:101893;CONF-8906287–: Max '91 workshop 2: developments in observations and theory for solar cycle 22, Laurel, MD (USA), 8-9 Jun 1989). In *Max '91 Workshop 2: Developments in Observations and Theory for Solar Cycle 22.* Available from NTIS, PC A17/MF A03.

Researchers describe the conceptual design of a new imaging vector magnetograph currently being constructed at the University

of Hawaii. The instrument combines a modest solar telescope with a rotating quarter-wave plate, an acousto-optical tunable prefilter as a blocker for a servo-controlled Fabry-Perot etalon, CCD cameras, and on-line digital image processing. Its high spatial resolution (1/2 arcsec pixel size) over a large field of view (5 by 5 arcmin) will be sufficient to significantly measure, for the first time, the magnetic energy dissipated in major solar flares. Its millisecond tunability and wide spectral range (5000 to 7000 A) enable nearly simultaneous vector magnetic field measurements in the gas-pressure-dominated photosphere and magnetically-dominated chromosphere, as well as effective co-alignment with Solar-A's X ray images. Researchers expect to have the instrument in operation at Mees Solar Observatory (Haleakala) in early 1991. They have chosen to use tunable filters as wavelength-selection elements in order to emphasize the spatial relationships between magnetic field elements, and to permit construction of a compact, efficient instrument. This means that spectral information must be obtained from sequences of images, which can cause line profile distortions due to effects of atmospheric seeing.

20583 (N–90-12459, pp. 328-337) **The Owens Valley solar array.** Hurford, G.J.; Gary, D.E. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. 1989. (NASA-TM–101893;NAS–1.15:101893;CONF-8906287–: Max '91 workshop 2: developments in observations and theory for solar cycle 22, Laurel, MD (USA), 8-9 Jun 1989). In *Max '91 Workshop 2: Developments in Observations and Theory for Solar Cycle 22.* Available from NTIS, PC A17/MF A03.

Solar microwave emission contains essential information for the study of the coronal magnetic structure of active regions and of thermal and nonthermal flare electrons. To exploit this potential requires BOTH imaging and spectroscopy with sufficient resolution to resolve spatial and spectral features. The VLA provides excellent solar imaging (when in the C and D configurations) but inadequate spectral coverage. The existing Owens Valley system has excellent spectral coverage but imaging that is adequate only for very simple sources. The Owens Valley system is currently undergoing an expansion, which when completed in October 1990 will provide a SOLAR-DEDICATED 5 antenna array (10 baselines). By using frequency-synthesis, this will provide a significant imaging capability in addition to its current spectral coverage.

20584 (N–90-12459, pp. 346-348) **A high-speed digital camera system for the observation of rapid H-alpha fluctuations in solar flares.** Kiplinger, A.L. (Colorado Univ., Boulder (USA)); Dennis, B.R.; Orwig, L.E. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. 1989. (NASA-TM–101893;NAS–1.15:101893;CONF-8906287–: Max '91 workshop 2: developments in observations and theory for solar cycle 22, Laurel, MD (USA), 8-9 Jun 1989). In *Max '91 Workshop 2: Developments in Observations and Theory for Solar Cycle 22.* Available from NTIS, PC A17/MF A03.

Researchers developed a prototype digital camera system for obtaining H-alpha images of solar flares with 0.1 s time resolution. They intend to operate this system in conjunction with SMM's Hard X Ray Burst Spectrometer, with x ray instruments which will be available on the Gamma Ray Observatory and eventually with the Gamma Ray Imaging Device (GRID), and with the High Resolution Gamma-Ray and Hard X Ray Spectrometer (HIREGS) which are being developed for the Max '91 program. The digital camera has recently proven to be successful as a one camera system operating in the blue wing of H-alpha during the first Max '91 campaign. Construction and procurement of a second and possibly a third camera for simultaneous observations at other wavelengths are underway as are analyses of the campaign data.

20585 (N–90-12459, pp. 310-319) **Investigation of active regions at high resolution by balloon flights of the Solar Optical Universal Polarimeter (SOUP).** Tarbell, T.; Frank, Z.; Gilbreth, C.; Shine, R.; Title, A.; Topka, K.; Wolfson, J. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. 1989. (NASA-TM–101893;NAS–1.15:101893;CONF-8906287–: Max '91 workshop 2: developments in observations and theory for solar cycle 22, Laurel, MD (USA), 8-9 Jun 1989). In *Max '91 Workshop 2: Developments in Observations and Theory for Solar Cycle 22.* Available from NTIS, PC A17/MF A03.

SOUP is a versatile, visible-light solar observatory, built for space or balloon flight. It is designed to study magnetic and velocity fields in the solar atmosphere with high spatial resolution and temporal uniformity, which cannot be achieved from the surface of the earth. The SOUP investigation is carried out by the Lockheed Palo Alto Research Laboratory, under contract to NASA's Marshall Space Flight Center. Co-investigators include staff members at a dozen observatories and universities in the U.S. and Europe. The primary objectives of the SOUP experiment are: to measure vector magnetic and velocity fields in the solar atmosphere with much better spatial resolution than can be achieved from the ground; to study the physical processes that store magnetic energy in active regions and the conditions that trigger its release; and to understand how magnetic flux emerges, evolves, combines, and disappears on spatial scales of 400 to 100,000 km. SOUP is designed to study intensity, magnetic, and velocity fields in the photosphere and low chromosphere with 0.5 arcsec resolution, free of atmospheric disturbances. The instrument includes: a 30 cm Cassegrain telescope; an active mirror for image stabilization; broadband film and TV cameras; a birefringent filter, tunable over 5100 to 6600 A with 0.05 A bandpass; a 35 mm film camera and a digital CCD camera behind the filter; and a high-speed digital image processor.

20586 (N–90-12492) **Cosmic strings and ultra-high energy cosmic rays.** Bhattacharjee, P. Chicago Univ., IL (USA). Sep 1989. 16p. (NASA-CR–185924;NAS–1.26:185924;FERMILAB-PUB–89/196-A). Available from NTIS, PC A03/MF A01.

The flux is calculated of ultrahigh energy protons due to the process of cusp evaporation from cosmic string loops. For the standard value of the dimensionless cosmic string parameter epsilon is identical to G(sub mu) approx. = 10(exp -6), the flux is several orders of magnitude below the observed cosmic ray flux of ultrahigh energy protons. However, the flux at any energy initially increases as the value of epsilon is decreased. This at first suggests that there may be a lower limit on the value of epsilon, which would imply a lower limit on the temperature of a cosmic string forming phase transition in the early universe. However, the calculation shows that this is not the case – the particle flux at any energy reaches its highest value at epsilon approx. = 10(exp -15) and it then decreases for further decrease of the value of epsilon. This is due to the fact that for too small values of epsilon (less than 10(exp -15)), the energy loss of the loops through the cusp evaporation process itself (rather than gravitational energy loss of the loops) becomes the dominant factor that controls the behavior of the number density of the loops at the relevant times of emission of the particles. The highest flux at any energy remains at least four orders of magnitude below the observed flux. There is thus no lower limit on epsilon.

20587 (N–90-13296) **Far infrared, submm and mm spectroscopy of the galactic center: Radio arc and +20/+50 km s (exp −1) clouds.** Genzel, R.; Stacey, G.J.; Harris, A.I.; Townes, C.H.; Geis, N.; Graf, U.U.; Poglitsch, A.; Stutzki, J. Max-Planck-Institut fuer Physik und Astrophysik, Garching (Germany, F.R.). Jul 1989. 52p. (NASA-CR–185497;NAS–1.26:185497;MPE-PREPRINT–155;ETN–89-95857). Available from NTIS, PC A04/MF A01.

The observations of the par improved spectroscopy and the molecular clouds at the galactic center are reported. The results show: the spatial distributions of C(II) 158 microns and molecular line radiation and of the thermal radio continuum emission in the arched filaments of the radio arc are similar; about 2 x 10(exp 4) of the solar mass, or 10 percent of the total gas mass in the radio arc, are contained in C(+) regions; the H(+)/C(+) regions are probably located at the surfaces of the dense molecular clouds in the arc. Profiles, fluxes and spatial distributions of the C(II) fine structure and CO rotational lines are reported. It is demonstrated that the data does not fit models in which the neutral interstellar clouds in the arc are ionized by shocks or by magnetohydrodynamic phenomena. Moreover, that the high temperatures and densities derived previously from NH3 and CS observations may not be characteristic of the bulk of the molecular gas.

20588 (N–90-13316) **Research in cosmic and gamma ray astrophysics. Annual status report.** Stone, E.C.; Davis, L. Jr.; Mewaldt, R.A.; Prince, T.A. California Inst. of Tech., Pasadena, CA

(USA). Mar 1989. 31p. (NASA-CR-185451;NAS-1.26:185451). Available from NTIS, PC A03/MF A01.

Research activities in cosmic rays, gamma rays, and astrophysical plasmas are covered. The activities are divided into sections and described, followed by a bibliography. The astrophysical aspects of cosmic rays, gamma rays, and of the radiation and electromagnetic field environment of the Earth and other planets are investigated. These investigations are performed by means of energetic particle and photon detector systems flown on spacecraft and balloons.

20589 (SLAC-328, pp. 277-323) **The dialogue between particle physics and cosmology.** Sadoulet, B. (Lawrence Berkeley Lab., CA (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jan 1988. (CONF-870821-: SLAC summer institute on particle physics: looking beyond the Z, Stanford, CA (USA), 10-21 Aug 1987). In *Looking beyond the Z: Proceedings.* Order Number DE88011870. Available from NTIS, PC A04/MF A01.

In the last decade, a very close relationship has developed between particle physics and cosmology. The purpose of these lectures is to introduce particle physicists to the many scientific connections between the two fields. Before entering into the discussion of specific topics, the author shows that particle physics and cosmology are completely interdependent. 171 refs., 35 figs., 4 tabs.

20590 (SLAC-PUB-5161) **The Inevitable Universe—Parker-Rhodes' peculiar mixture of ontology and physics: The second Parker-Rhodes memorial lecture.** Noyes, H.P. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Dec 1989. 21p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (CONF-8909297-1: 11. annual international meeting of the Alternative Natural Philosophy Association, Cambridge (UK), 14-17 Sep 1989). Order Number DE90006453. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

When asked to give a lecture on Parker-Rhodes' physics, I was somewhat non-plused. I almost replied "What physics?" — a point of view that Frederick expresses himself more than once in the book he was working on when he died. But that would be unjust. Whatever his view, I assert that the discovery of the Combinational Hierarchy is one of the most important "discoveries" — or whatever you want to call it — in physics made in this century. His calculation of the proton-electron mass ratio is also a fantastic result that we are still trying to come to grips with. And his insight into early cosmology — what he called a "cold big bang" — which appeared in an early version of the Theory of Indistinguishables, also had merit. His early universe is a lot closer to my own views now than I realized when I first encountered it. We will mention other insights as I go along. But his views are so different from those of anyone I know or knew, that I have decided to let him speak for himself by reading passages from his manuscript The Inevitable Universe, or TIU, which was still unpublished at the time of his death, and add a few comments on them.

20591 (UCID-21844) **Temporal response of atmospheric turbulence compensation.** Karr, T.J. Lawrence Livermore National Lab., CA (USA). 1 Dec 1989. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90006354. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The temporal kernel for the phase error variance due to atmospheric turbulence is calculated. This kernel, convolved with the servo transfer function, determines the error of any turbulence compensation scheme. 15 refs., 2 figs.

20592 (UCRL-101123) **Accretion flows in high mass star formation.** Keto, E. Lawrence Livermore National Lab., CA (USA). 12 May 1989. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-8904318-1: I.A.U. colloquium on structure and dynamics of the interstellar medium conference, Granada (Spain), 17-26 Apr 1989). Order Number DE90007251. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We compare observed and simulated images of the accretion flows associated with high mass star formation in the regions G10.6–0.4 and DR21. We describe, as a result of the comparison, the temperature, density, and velocity fields. Our results indicate that the G10.6–0.4 cloud core is strongly condensed and has approximately equal velocities in rotation and infall at its current evolutionary state. The rapid collapse and lack of rotational support suggests that significant angular momentum transfer is occurring over scales at least as large as those observed (0.5 pc). A milligauss magnetic field would have sufficient energy to supply the required braking torque of 10^{47} ergs. The DR21 core shows approximately spherically symmetric radial accretion with no detectable rotation. Unlike the G10.6–0.4 core, the DR21 core does not contain an embedded HII region. Thus this core may represent a molecular cloud condensation undergoing gravitational collapse and accretion just prior to the formation of massive stars. 7 refs., 5 figs., 1 tab.

20593 (UCRL-102659) **Gamma ray astronomy and black hole astrophysics.** Liang, E.P. Lawrence Livermore National Lab., CA (USA). 3 Jan 1990. 8p. Sponsored by U.S. DOE Defense Programs; National Aeronautics and Space Administration. DOE Contract W-7405-ENG-48. CONTRACT NGR 05-020-668. (CONF-891276-3: Workshop on high energy astrophysics in the 21st century, Taos, NM (USA), 10-14 Dec 1989). Order Number DE90007253. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

One of the most exciting recent development in black hole astrophysics is the discovery by the HEAO-3 experiment of transient enhanced MeV gamma ray emissions from Cygnus X-1 and the Galactic Center, and the potentially correlated appearance of the 511 keV annihilation line from the Galactic Center (Ling et al 1987, Riegler et al 1985). If these soft gamma ray bumps and annihilation lines can be proven to be universal signatures of black hole accretions, then they will provide a new window on the overall black hole phenomenon from stellar mass black holes to AGNs. Hence it is important for future high energy astrophysics space missions to incorporate the study of soft gamma emissions from black hole candidates as a major component of their scientific goals. This paper discusses these goals. 14 refs., 4 figs.

20594 (UCRL-102762) **A large area, low cost, gamma-ray, imaging spectrometer.** Ziock, K.P.; Hailey, C.J. Lawrence Livermore National Lab., CA (USA). Jan 1990. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-891276-1: Workshop on high energy astrophysics in the 21st century, Taos, NM (USA), 10-14 Dec 1989). Order Number DE90006993. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We are developing a low-cost per unit-area, imaging, low-energy (.1–10 MeV) gamma-ray spectrometer. This device has excellent position resolution (~2 mm @ 511 keV), near unity quantum efficiency and an energy resolution typical of alkali halide-type detectors. The low unit cost is achieved through separation of the energy and position sensing functions in an alkali halide-based gamma-ray detector. 5 refs., 3 figs.

20595 (UCRL-102763) **Imaging Germanium Telescope Array for Gamma-Rays (IGETAGRAY).** Hailey, C.J. (Lawrence Livermore National Lab., CA (USA)); Ziock, K.P.; Harrison, F.A.; Fleischmann, J. Lawrence Livermore National Lab., CA (USA). Jan 1990. 4p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-891276-2: Workshop on high energy astrophysics in the 21st century, Taos, NM (USA), 10-14 Dec 1989). Order Number DE90006994. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Germanium Drift Chamber (GDC) is a gamma-ray detector with excellent energy and one-dimensional spatial resolution. Due to recent developments in coded aperture optics, it is feasible to couple one-dimensional coded apertures and GDCs in a special array geometry producing a telescope with true two-dimensional imaging. This Imaging Germanium Telescope Array for Gamma-Rays (IGETAGRAY) has made a comparable field of view and sensitivity to true two-dimensional systems, but simplified engineering requirements. IGETAGRAY will make possible high sensitivity spectroscopy of the gamma-ray sky. 5 refs., 1 fig.

20596 **Precision experiments to search for the fifth force.** Faller, J.E. (Joint Institute for Lab. Astrophysics, National Bureau of Standards, Boulder, CO (US)); Speake, C.C.; Fischbach, E.; Fujii,

Y.; Kuroda, K.; Paik, H.J. *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Instrumentation and Measurement (USA)*, 38(2): 180-188 (Apr 1989).

The suggestion of a possible new fifth force of nature, has prompted a large number of high precision experiments to search for its presence. After reviewing the motivation for this suggestion, the authors describe some of the experiments that are presently underway, and the results that have been obtained to date.

20597 Neutrino masses and lifetimes from supernova observations. Soares, J.M. (Department of Physics, Carnegie Mellon University, Pittsburgh, Pennsylvania 15213 (US)); Wolfenstein, L. *Physical Review [Section] D: Particles and Fields (USA)*, 40(11): 3666-3669 (1 Dec 1989).

Observations of the arrival times and energies of neutrinos from a supernova can provide information on the masses and lifetimes of ν_μ and ν_τ for masses above 100 eV. Cosmological arguments suggest that for masses above 10 keV the neutrinos from a supernova at 10 kpc should decay before reaching Earth. If this is true the maximum median time delay for any mass is less than a day and so all masses up to 1 MeV can be detected if the lifetime is not too short. Time and energy distributions are presented.

20598 Large-scale cosmic microwave background anisotropies in isocurvature baryon open universe models. Gorski, K.M. (Los Alamos National Lab., NM (USA)); Silk, J. *Astrophysical Journal (USA)*, 346: L1-L4 (Nov 1989).

The large-angular-scale cosmic microwave background anisotropy is calculated in a low-density baryon-dominated universe with isocurvature primordial inhomogeneities. In models in which the initial power spectra of perturbations are steeper than white noise, predictions for the quadrupole moment of the anisotropy are found to be in conflict with existing observational limits, if the universe remained fully ionized and Compton drag inhibited growth of inhomogeneities until z = about 100. In order to lower the amplitude of the anisotropy, it is necessary to substantially prolong the duration of the growth phase of density perturbations, while smearing out fine-scale anisotropies, thereby requiring reionization to occur at a redshift smaller than 100, but larger than the redshift of the last scattering surface (in a reionized model). 21 refs.

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Refer also to citation(s) 21014, 21024

20599 (AD-A-214007/7/XAB) **Consequences of using simple analytical functions for the high-latitude convection electric field.** Rich, F.J.; Maynard, N.C. Air Force Geophysics Lab., Hanscom AFB, MA (USA). 1 Apr 1989. 16p. (GL-TR-89-0283). Available from NTIS, PC A03/MF A01.

Pub. in Jnl. of Geophysical Research, Vol. 94, No. A4, 3687-3701(1 Apr 1989).

Analytical functions are developed to represent the convection electric field of Heppner and Maynard (1987), which are realistic representations of the field. The functions include an explicit variability with geomagnetic activity for southward interplanetary magnetic field (IMF). The authors have used a simple computer algorithm to model the ionosphere and investigate the consequences of using the Heppner-Maynard analytical functions for the high-latitude convection electric field. The Heelis et al. (1982) model, which has been widely used by investigators with computer simulations of the magnetosphere, ionosphere and/or thermosphere, is used here to provide a comparison. The Heppner-Maynard functions improve on the simple Heelis function for southward IMF. The Heppner-Maynard functions yield resonable configurations and magnitude for Joule heating and field-aligned currents for a southward IMF. The Heelis model may not yield reasonable results depending on the input parameters. The major differences between the Heppner-Maynard functions and the Heelis function for southward IMF are for regions near (1) the dayside cusp, (2) the Harang discontinuity and (32) the subauroral latitudes. In general, the Heppner-Maynard functions yield results that more closely compare with other investigators. For northward IMF, the functional representations of the Heppner-Maynard do not reproduce the field-aligned currents in the polar cap which have been referred to as the NBZ current system.

20600 (AD-A-214008/5/XAB) **Rocket measurements within a polar-cap arc: Plasma, particle, and electric circuit parameters.** Weber, E.J.; Kelley, M.C.; Ballenthin, J.O.; Basu, S.; Carlson, H.C. Air Force Geophysics Lab., Hanscom AFB, MA (USA). 1 Jun 1989. 23p. (GL-TR-89-0280). Available from NTIS, PC A03/MF A01.

Pub. in Jnl. of Geophysical Research, Vol. 94, No. A6, 6692-6712(1 Jun 1989).

An instrumented rocket payload was launched into a polar-cap F-layer aurora to investigate the energetic particle, plasma, and electric circuit parameters of a Sun-aligned arc. On-board instruments measured energetic electron flux, ion composition and density fluctuations, electron density and temperature, electron density fluctuations, and ac and dc electric fields. The payload traversed a rapidly moving Sun-aligned, F-layer arc near apogee (429 km altitude). Real-time all-sky imaging-photometer measurements of the location and motion of the aurora, conducted from an aircraft in the vicinity of the trajectory, were used to determine the proper geophysical situation for launch. Comparison of the in situ measurements with remote optical measurements shows that the arc was produced by fluxes of low-energy (< keV) electrons. Field-aligned potentials in the arc inferred from the electron spectra had a maximum value of approximately 300 V, and from the spectral shape a parent population of preaccelerated electrons characteristic of the boundary plasma sheet or magnetosheath was inferred. Electric field components along and across the arc show sunward flow within the arc and duskward drift of the arc consistent with the drift direction and speed determined from optical imaging.

20601 (AD-A-214013/5/XAB) **Strategic Characteristics of Dynamics Explorer. 1. Retarding-Ion Mass Spectrometer and the Consequences for Core Plasma Measurements. Technical report for September 1989.** Olsen, R.C. Naval Postgraduate School, Monterey, CA (USA). 14 Sep 1989. 54p. (NPS-61-89-014). Available from NTIS, PC A04/MF A01.

The Retarding Ion Mass Spectrometer (RIMS) on the Dynamics Explorer I (DE I) satellite has provided a new range of data, and challenges for studies of the core plasma of the magnetosphere. Analysis of the RIMS data provides a measure of the satellite potential in the inner magnetosphere. As the satellite leaves the inner plasmasphere, it begins to charge positively, crossing the 0 V mark at about 1000/cc. The potential rises slowly initially, reaching about 1 V near the plasmapause, at the 100/cc point. At lower densities, the potential rises relatively rapidly, reaching +5 V or greater at the 10/cc point. For satellite potentials of +1 to +5 V, portions of the ion distribution function are lost to measurement because the ions are repelled by the satellite. In particular, in a multi-temperature plasma, the cold component is easily lost in this potential (density) regime. It is in this regime where aperture bias techniques have been successfully used, particularly in measurements of field-aligned ion flows such as the polar wind, which have sufficient kinetic energy to overcome electrostatic barriers in front of the aperture plane. At lower densities (<10/cc), the satellite potential can exceed +5 V. At such potentials the core plasma is lost to the RIMS, and even the aperture bias techniques are no lower successful.

20602 (AD-A-214130/7/XAB) **Chemical interactions and light emissions from vented species. Final report, June 1988-March 1989.** Bernhardt, P.A.; Mulbrandon, M.J. Naval Research Lab., Washington, DC (USA). 20 Oct 1989. 45p. (NRL-MR-6527). Available from NTIS, PC A03/MF A01.

Airglow emissions may be induced by the interaction of atmospheric constituents with vapors released from space vehicles. Such emissions can be produced by a number of chemical mechanisms. This study considers neutral-plasma reactions as well as neutral-neutral reactions as the sources for excited species. The intensities of light emissions produced by the release of water and methyl alcohol into the upper atmosphere is estimated with a numerical mode. Chemical reactions between the injected neutrals, background ions, electrons, and neutrals, and artificially created ions and neutrals are considered. OH is the primary excited species resulting from the water release. Vibrational and electronic

states of OH will be excited to yield emission spectra between 240- and 4400-nm wavelengths. For the release of 10^{26} molecules in the nighttime ionosphere with a density of 10^6/cu. cm, the intensities of the emissions will be greater than .0001 Rayleighs. The water release also produces vibrational states of H_2O and electronic states of atomic oxygen. The addition of methyl alcohol to the release causes substantial production of vibrationally excited formaldehyde. We conclude that the venting of reactive molecules into the upper atmosphere at 300 km altitude or above can produce excited species by neutral-neutral, ion-neutral, or electron-ion reactions. No one reaction process is dominant in the F region.

20603 (AD-A–214203/2/XAB) **Polar Bear uv images of airglow and aurora: Data reduction and analysis. Technical report, September 1987-September 1988.** Tur, M.; Osnovich, I. Tel Aviv Univ. (Israel). School of Engineering. 29 Sep 1988. 37p. (SCIENTIFIC–1). Available from NTIS, PC A03/MF A01.

The AIRS scanning ultraviolet photometer aboard the Polar Bear satellite was launched in late 1986. It was designed to obtain UV images with high spatial and wavelength resolution at several emission lines simultaneously. The objective of the program is to geometrically and photometrically calibrate the data. The processing is designed to provide kilometer-scaled images that can be projected upon various coordinate systems. These tools afford studies of the spatial and temporal variability of airglow and aurora. Each data-stream from a pass is converted to a 240 x 240 image representing 5000 x 5000km records of intensity. The major progress during the report period has been modification and development of programs to accomplish the following: (1) A Chapman function correction to the solar flux dependence of the intensity, resulting with a successful daytime fit of power unity of above variable to pixel brightness. (2) Separation of night-glow domain to ordinary and continuous (24 hr) night regions. (3) Projection of images onto dipole & corrected geomagnetic coordinate systems. (4) Comparison of auroral arcs with known auroral oval and initiation of a UV oval from input images.

20604 (AD-A–214400/4/XAB) **High-spatial-resolution study of the thermospheric response to a discrete auroral arc. Final report.** Eastes, R.W.; Killeen, T.L.; Carrignan, G.R.; Hedin, A.E.; Spencer, N.W. Air Force Geophysics Lab., Hanscom AFB, MA (USA). 16 Feb 1989. 20p. (AFGL-TR–89-0043). Available from NTIS, PC A03/MF A01.

A sequence of three high-latitude passes by the De-2 spacecraft was studied using high-spatial-resolution data from several instruments to investigate the local thermospheric response to a discrete auroral arc. Three passes, orbits 1847, 1848, and 1849, which occurred on 6 December 1981, cross an isolated, discrete arc in the evening auroral oval. Observations of neutral winds, ion winds, neutral densities, energetic electron spectrum, and neutral temperatures were examined at a spatial resolution of approximately 8 km. The observations illustrate the response of the thermosphere to the local insertion of energy and momentum and provide the basis for a more critical test of the various theoretical models that have predicted local thermospheric phenomena. The results are presented and discussed in relation to the predictions of three such local models.

20605 The plasma wake of the space shuttle Orbiter. Wright, K.H. (Marshall Space Flight Center, Huntsville, AL (US)); Stone, N.H.; Reasoner, D.L.; Samir, U.; Hwang, K.S. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

During the Spacelab 2 mission of the space shuttle, a small subsatellite, the Plasma Diagnostic Package (PDP), was released for six hours of free flight. Measurements of the ion behavior in the mid- and far wake of the Orbiter are presented. This data was obtained by the Differential Ion Flux Probe (DIFP) and by the Retarding Potential Analyzer (RPA), which were mounted on the PDP. The disturbance to the ionosphere produced by the Orbiter motion was found to extend downstream beyond 250 m. Evidence for the influence of the magnetic field on the wake morphology is noted. The wake data is compared and contrasted with laboratory simulations of the interaction of a body in a flowing plasma.

20606 Plasma processes associated with a rapidly moving magnet in the ionosphere. Sullivan, J.D. (Massachusetts Inst. of Tech., Cambridge, MA (USA)); Davidson, R.C.; Binsack, J.H.; Chang, T.S.; Lane, B.G.; Goertz, C.K.; Kelley, M.C.; Mendillo, M.J.; Primdahl, F. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Plasma measurements in the vicinity of a large, high-intensity magnet moving rapidly through the ionosphere would provide a unique opportunity to study in detail many of the plasma processes (e.g., reconnection anomalous diffusion, wave-particle interactions, etc.) that occur naturally throughout the solar system and in other astrophysical contexts, and an opportunity to develop a basic understanding and test theoretical models in new parameter regimes. The large, collisionless, wall-less plasma environment (the ionosphere) makes the investigation of considerable general interest to plasma physics since several fundamental plasma processes, not otherwise accessible to laboratory experimentation, might be observed and measured quantitatively. This paper focuses on the illustrative transport and instability processes.

20607 DuBois replies. DuBois, D.F. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (US)). *Physical Review Letters (USA)*, 63(23): 2611 (4 Dec 1989).

A reply to the comment on caviton correlations is presented. The authors accepts because of space limitations the arguments in Ref. 2 were clearly incomplete and in the intervening time own understanding of these points has improved. (AIP)

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Refer also to citation(s) 19481, 19910, 19914, 19936, 19949, 19984, 20130, 20941, 20943, 20951, 20972, 21020, 21039, 21055, 21064, 21065, 21073

20608 (AD-A–214440/0/XAB) **Laser cooling of neutral atoms. Final report, 22 July 1983-30 September 1988.** Metcalf, H. State Univ. of New York, Stony Brook, NY (USA). Dept. of Physics. Oct 1989. 24p. Available from NTIS, PC A03/MF A01.

A new cooling process was discovered that uses an applied magnetic field to mix differentially light-shifted atomic-ground-state sublevels. It seems to be another form of the polarization scrambling mo'asses that was appropriate for the ultra-cold measurements on the three-dimensional Na molasses at the NBS last year, except that this is a one-dimensional (or perhaps two-dimensional) version. Optical collimation experiments were performed in two dimensions to make a very intense beam of atoms. Measuring a beam profile in two dimensions would require two hot wires scanning in perpendicular directions, and any asymmetry in the line shape could produce ambiguity. It is therefore very desirable to have a neutral atom imaging device. Diode Laser Experiments; High Vacuum System for trap and Molasses; magnetic Trapping of Neutral Atoms; Trapping Metastable Helium; the earliest experiments on optical pumping of helium there has been interest in generating light to excite the first resonance transition from the metastable 2 3S1 state to the 2/3P(O,1,2) states (lifetime tau approx 95 nsec). For 25 years these experiments were done with light from resonance lamps, but the advent of LNA in 1985 provided the opportunity for laser excitation of this important transition.

20609 (ANL–89/39) **A systematic analysis of the spectra of trivalent actinide chlorides in D_{3h} site symmetry.** Carnall, W.T. Argonne National Lab., IL (USA). Nov 1989. 285p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. Order Number DE90008104. Available from NTIS, PC A13/MF A01; OSTI; INIS; GPO Dep.

The optical spectra of actinide ions in the compound $AnCl_3$ and doped into single crystal $LaCl_3$ were interpreted in terms of transitions within $5f^N$ configurations. Energy-level calculations were carried out using an effective operator Hamiltonian, the parameters

of which were determined by fitting experimental data. Atomic and crystal-field matrices were diagonalized simultaneously assuming an approximate D_{3h} site symmetry. The spectroscopic data were taken from the literature but in most cases supplemented by unpublished measurements in absorption and in fluorescence. Spectroscopic data for each ion were analyzed independently, then the model parameters were intercompared and in many cases adjusted such that in the final fitting process the principal interactions showed uniform trends in parameter values with increasing atomic number. Consistent with analyses of the spectra of lanthanide ions in both $LaCl_3$ and LaF_3, abrupt changes in magnitude of certain crystal-field parameters were found near the center of the $5f^N$-series. This resulted in two groups of parameter values, but with consistent trends for both halves of the series, and generally very good agreement between observed and computed energies. A new energy level chart based on computed crystal-field level energies for each trivalent actinide ion has been prepared. in addition, the parameters of the atomic part of each $5f^N$ Hamiltonian were used to calculate the matrix elements of $U^{(\lambda)}$ for selected transitions. The values were tabulated to facilitate calculation of intensity-related parameters for $5f^N$-transitions using the Judd-Ofelt theory. 44 refs., 10 figs., 3 tabs.

20610 (CEA-CONF–9838) **Polarization observables in elementary K^+-production.** Adelseck, R.A.; Saghai, B. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique Nucleaire a Haute Energie. 1989. 18p. (CONF-8903172–:). Order Number DE90752550. Available from NTIS (US Sales Only), PC A03/MF A01.

The theoretical and experimental status of positive kaon photoproduction off protons from threshold up to 1.4 GeV is briefly reviewed. A model based on Feynman diagrams including several hadronic resonance exchanges is presented. The results of this model are compared with the differential cross section and the Lambda-polarization asymmetry data. Predictions on other polarization observables are reported and the need for further measurements is emphasized.

20611 (CEA-CONF–9848) **Study of Coulomb and dispersive effects by comparison of electron and positron scattering on nuclei.** Breton, V. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique Nucleaire a Haute Energie); Amroun, A.; Bricault, P.; Dreux, P.; Frois, B.; Goutte, D.; Phan, X.H.; Platchkov, S.K.; Isabelle, D.; Cardman, L.C. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique Nucleaire a Haute Energie. 1989. 6p. (CONF-8903172–:). Order Number DE90752529. Available from NTIS (US Sales Only), PC A02/MF A01.

We have compared electron and positron elastic scattering cross sections on ^{208}Pb and ^{12}C for momentum transfer up to 2 fm^{-1}. These comparisons show that the corrections for Coulom distorsions and dispersive effects, used in the analysis of electron scattering experiments, are accurate within 2%.

20612 (DOE/ER/13429–5) **Supersonic bare metal cluster beams: Technical progress report, July 16, 1989–February 10, 1990.** Smalley, R.E. Rice Univ., Houston, TX (USA). Dept. of Chemistry. [1990]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-85ER13429. Order Number DE90007363. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The majority of our research efforts this past year in the area of bare metal clusters have focussed in two areas: ultraviolet photoelectron spectra (UPS) of bare, mass-selected transition metal clusters, and a continuation of our surface chemistry studies on the cluster ICR apparatus. In both cases the work has involved extensive continued efforts to improve the intensity, cooling, and reproducibility of the laser vaporization cluster source. A major success has been achieved here that should substantially accelerate progress in the cluster beam field. In what follows, I will briefly discuss this new source, then treat the UPS and ICR activities in turn.

20613 (DOE/ER/13630–3) **Many-body processes in atomic and molecular physics: Progress report, September 1, 1989–August 31, 1990.** Chu, Shih-I. Kansas Univ., Lawrence, KS (USA). Dept. of Chemistry. Feb 1990. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER13630. Order Number DE90007230. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This report discusses the following topics: Dynamics of Multiphoton Excitation in Rydberg Atoms; Nonlinear Schrodinger Equation and Dissipative Quantum Dynamics in Periodic Fields; Density Matrix Formulation of Complex Geometric Phases in Dissipative Systems; and A. C. Stark Shifts of Excited States of Atoms in Strong Fields.

20614 (DOE/ER/52144–T1) **Development of an rf-driven plasma neutralizer for negative ions: Final technical report, September 1, 1988–August 31, 1989.** Moses, K.G. JAYCOR, Torrance, CA (USA). Plasma Technology Div. 30 Nov 1989. 29p. Sponsored by U.S. DOE Energy Research. DOE Contract FG03-87ER52144. (J–550-89-505/2513). Order Number DE90007298. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The assertion that beams of negative ions can be neutralized more efficiently by impacting a plasma, rather than a cold gas target, is confirmed scientifically by the work of K.H. Berkner et al. What remains to be done is the realization of practical means of generating plasmas efficiently with appropriate integrated line densities (target thickness). The work performed by JAYCOR, under this grant, over the past few years has made significant progress towards that goal. In this work, large volumes of plasma are generated using low-frequency pulsed inductive rf discharges within a ring cusp multipole-magnetic field geometry. These plasmas exhibit sufficient line-integrated electron densities and degrees of ionization to neutralize beams of energetic negative ions whose energies exceed 500 keV. The method of plasma generation and the cell configuration used in these studies are directly applicable to higher energy neutral beam injector systems (NBIS). Innate scalability and modularity of the system design facilitates linear stacking to achieve a desired target thickness. Further, the plasma formation process is accomplished with an electrical economy consistent with increased overall electrical efficiency of the NBIS compared to that possible using a cold gas target. 5 refs., 16 figs.

20615 (INP–1341/PL) **Nuclear magnetic relaxation of methyl group in liquids.** Blicharska, B. (Uniwersytet Jagiellonski, Cracow (Poland). Inst. Fizyki). Institute of Nuclear Physics, Cracow (Poland). 1986. 85p. Order Number DE90616684. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

The theoretical description of the relaxation process of methyl group in liquids and some results of the measurements of relaxation function and relaxation times for cryoprotective solutions are presented. Starting from the application of the operator formalism the general equation for spin operators e.g. components of the nuclear spin and magnetization is founded. Next, the spin Hamiltonian is presented as contraction of the symmetry adapted spherical tensors as well as the correlation functions and spectral densities. On the basis of extended and modified Woessner model of motion the correlation functions and spectral densities are calculated for methyl group in liquids. Using these functions the relaxation matrix elements, the spin-spin and spin-lattice relaxation times can be expressed. The prediction of the theory agrees with author's previous experiments on cryoprotective solutions. The observed dependence on temperature, frequency and isotopic dilution in methanol-water, methanol-dimethyl sulfoxide (DMSO) and DMSO-water solutions is in a satisfactory agreement with theoretical equations. 34 refs. (author).

20616 (LA–11725-MS) **The electron momentum-transfer cross sections of tungsten, silicon, and silicon dioxide at energies from 0.1 to 10,000 eV.** Devaney, J.J. Los Alamos National Lab., NM (USA). Jan 1990. 19p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. Order Number DE90009041. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

For the purpose of estimating effective stopping of low energy electrons in a particular direction, the momentum-transfer cross sections of Tungsten, Silicon, and Silicon Dioxide are furnished. The elastic scattering momentum-transfer cross sections are obtained by integration over the differential elastic scattering cross sections either in the individual references or in this paper numerically. At 10eV and below the elastic scattering momentum-transfer cross sections were also obtained (Itikawa) from the total scattering

cross section, swarm experiments and the microwave method, as well as theoretical calculations. The inelastic collision momentum-transfer cross sections were calculated from the electron stopping powers by an approximate theory due to Devaney. The total momentum-transfer cross section is then the sum of the elastic scattering and the inelastic collision cross sections. 9 refs., 4 tabs.

20617 (LA-UR-90-176) **Los Alamos LEDCOP Opacity Code.** Magee, N.H. Jr.; Merts, A.L. Los Alamos National Lab., NM (USA). 1989. 25p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-36. (CONF-8908210-1: 1. international LTE opacity workshop and code comparison study, Abingdon (UK), 30 Aug - 5 sep 1989). Order Number DE90008636. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Los Alamos Light Element ($Z \leq 30$) Detailed Configuration Opacity Code (LEDCOP), used to calculate opacities in local thermodynamic equilibrium (LTE), has been rewritten to incorporate more detailed atomic physics input. This paper outlines the recent improvements in the code that will provide new Rosseland opacities and, more importantly, better group mean opacities for modern radiation-hydrodynamic codes. The first major area of improvement is the inclusion of a complete set of accurate and internally-consistent Hartree-Fock LS term energies and oscillator strengths for each element. While relatively unimportant for equation of state (EOS), this does provide an improved distribution of line energies and strengths for group mean opacities. Secondly, the code now used Hartree-Fock photoionization cross sections for all ground and excited configurations of all ionization stages. These new cross sections are consistent with the bound-bound oscillator strengths and in many cases their inclusion affects the opacity more than the new LS oscillator strengths. 11 refs., 16 figs.

20618 (ORNL/OMIS-89/9) **The optical properties of beryllium.** Arakawa, E.T. (Oak Ridge National Lab., TN (USA)); Callcott, T.A.; Chang, Yun-ching. Oak Ridge National Lab., TN (USA). Feb 1990. 29p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90006372. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We review the published data on the optical properties of beryllium for the spectral region from 0.03 to 300 eV. In the visible and infrared spectral regions, where published data from various authors show very large variations, we have performed experiments that identify the most probable sources of error, and use this information to select the best data from published sources. The effects of surface oxide overlayers have also been studied. In the far infrared spectral region, where only normal incidence reflectance data are available, and in the extreme ultraviolet, where only transmission data are available, there is insufficient information to fully determine the optical properties at each photon energy. Between 0.06 and 26 eV, however, a normal incidence reflectance curve is fully determined. This curve has been used for a Kramers–Kronig analysis to determine the optical properties in this spectral range. 10 refs., 13 figs., 3 tabs.

20619 (SINS-2050/P-2/PL/A) **Inner shell ionization accompanying nuclear collisions.** Sujkowski, Z. Institute for Nuclear Studies, Otwock-Swierk (Poland). Nov 1987. 47p. Order Number DE90616698. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Received in 1989.

Selected phenomena leading to inner shell ionization and being of relevance for nuclear physics are discussed. The selection emphasizes the K-shell ionization induced in head-on collisions by fast light and medium-heavy ions. Cross-sections are reviewed. Effects of multiple inner shell ionization on the K X-ray spectra are illustrated with recent results. Implications for nuclear experiments are noted. Use of atomic observables as clocks for proton induced nuclear reactions is reviewed. Prospects for H.I. reactions are discussed. Preliminary experimental results on the direct K-shell ionization accompanying H.I. fusion reactions are presented. The post-collisional K-shell ionization due to internal conversion of gamma-rays is discussed as the dominating contribution to the ionization for residues of dissipative nuclear reactions with $Z>40$. Systematics of the corresponding K X-ray multiplicities is presented for rotational nuclei. These multiplicity values can be used for determining cross-sections for e.g. incomplete fusion reactions. Examples of such applications are given. The use of target K X-rays for normalization purposes and of the post-collisional, residue K X-rays in the studies of high spin phenomena is also discussed. 96 refs., 35 figs., 3 tabs. (author).

20620 (SINS-2055/P-2/PL/A) **Non-binomial distribution of palladium K_{alpha} L^n X-ray satellites emitted after excitation by ^{16}O ions.** Rymuza, P. (Institute for Nuclear Studies, Otwock-Swierk (Poland)); Sujkowski, Z.; Carlen, M.; Dousse, J.C.; Gasser, M.; Kern, J.; Perny, B.; Rheme, C. Institute for Nuclear Studies, Otwock-Swierk (Poland). Feb 1988. 8p. (CONF-8708135-: 3. workshop on high energy ion-atom collisions, Debrecen (Hungary), 3-5 Aug 1987). Order Number DE90616699. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Received in 1989.

The palladium K_{alpha} L^n X-ray satellites spectrum emitted after excitation by 5.4 MeV/u ^{16}O ions has been measured. The distribution of the satellites yield is found to be significantly narrower than the binomial one. The deviations can be accounted for by assuming that the L-shell ionization is due to two uncorrelated processes: the direct ionization by impact and the electron capture to the K-shell of the projectile. 12 refs., 1 fig., 1 tab. (author).

20621 (UCID-21950) **A simple model for amplified spontaneous emission in dyes.** Garrison, J.C.; Hong, Chung Ki; Nathel, H. Lawrence Livermore National Lab., CA (USA). 9 Jan 1990. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90007249. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Amplified spontaneous emission in dyes is modelled by replacing the actual molecular spectrum by an effective four-level atom which includes the levels involved in pumping and stimulated emission. Propagation of the signal and pump waves is described in the slowly varying envelope approximation. It is shown that the saturation intensity of the signal depends on the pump intensity, and reciprocally that the pump saturation intensity depends on the signal intensity. 1 fig.

20622 (UCRL-102651) **The dynamics of electrons in very intense lasers.** Bardsley, J.N.; Penetrante, B.M. Lawrence Livermore National Lab., CA (USA). 27 Nov 1989. 14p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-8907183-1: Aspects of electron-molecule scattering and photoionization, New Haven, CT (USA), 22-25 Jul 1989). Order Number DE90007246. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The dynamics of relativistic plasmas created by intense short-pulsed lasers is illustrated using analytic solutions for unconstrained electrons and numerical simulations of space-charge effects. These models provide a basis for the analysis of laser-induced nuclear reactions, recombination lasers and wakefield accelerators. 22 refs., 7 figs.

20623 (UCRL-102673) **Linear theory of thermal blooming in turbulence.** Chambers, D.H. (Lawrence Livermore National Lab., CA (USA)); Karr, T.J.; Morris, J.R.; Cramer, P.; Viecelli, J.A.; Gautessen, A.K. Lawrence Livermore National Lab., CA (USA). 16 Jan 1990. 10p. Sponsored by U.S. Department of Defense; U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Contract W31RPD-7-D4041. (CONF-900140-9: SPIE optics, electro-optics and laser applications in science and engineering conference and exhibition, Los Angeles, CA (USA), 20-25 Jan 1990). Order Number DE90007243. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

In this paper we show how the electric field spectrum for a high energy laser beam propagating through a uniform atmosphere can be calculated using the linear theory of small fluctuations. The beam is modeled analytically as an infinite plane wave which propagates through a medium with constant absorption and no transverse wind. Return-wave phase compensation is modeled as a filter in the transverse wind. Return-wave phase compensation is modeled as a filter in the transverse Fourier domain. The linear theory describes the growth of small fluctuations on the beam and accurately predicts the evolution of the electric field spectrum until

the magnitude of the fluctuations approach the original beam irradiance. The accuracy is tested by comparing with the spectrum calculated using ORACLE, a full wave optics thermal blooming code. 4 refs., 3 figs.

20624 Applications of the semiclassical spectral method to nuclear, atomic, molecular, and polymeric dynamics. Koszykowski, M.L. (Dept. of Chemistry, Univ. of Nebraska at Omaha, Omaha, NE (US)); Pfeffer, G.A.; Noid, D.W. pp. 155 of Chaotic phenomena in astrophysics. Buchler, J.R.; Eichhorn, H The N.Y. Academy of Sciences, New York, NY (1987). DOE Contract AC05-84OR21400. (CONF-8610389–: Chaotic phenomena in astrophysics, Gainesville, FL (USA), 9-10 Oct 1986).

Nonlinear dynamics plays a dominant role in a variety of important problems in chemical physics. Examples are unimolecular reactions, infrared multiphoton decomposition of molecules, the pumping process of the gamma ray laser, dissociation of vibrationally excited state-selected van der Waals's complexes, and many other chemical and atomic processes. The present article discusses recent theoretical studies on the quasi-periodic and chaotic dynamic aspects of vibrational-rotational states of atomic, nuclear, and molecular systems using the semiclassical spectral method (SSM). The authors note that the coordinates, momenta, and so on, are found using classical mechanics in the studies included in this review. They outline the semiclassical spectral method and a wide variety of applications. Although this technique was first developed ten years ago, it has proved to be tremendously successful as a tool used in dynamics problems. Applications include problems in nonlinear dynamics, molecular and atomic spectra, surface science, astronomy and stellar dynamics, nuclear physics, and polymer physics.

20625 Photoemission Cross Sections for Atomic Transitions in the Extreme Ultraviolet due to Electron Collisions with Atoms and Molecules. van der Burgt, P.J.M. (Atomic Collisions Laboratory, Department of Physics, North Carolina State University, Raleigh, North Carolina 27695-8202 (US)); Westerveld, W.B.; Risley, J.S. *Journal of Physical and Chemical Reference Data (USA),* 18(4): 1757-1805 (Oct 1989).

This article reviews experimental photoemission cross sections in the extreme ultraviolet, for transitions in excited atoms and atomic ions formed in electron collisions with atoms and molecules. A survey of the available experimental data for each investigated target gas reveals severe inconsistencies between cross sections reported by different laboratories. As almost all reported cross sections are based on relative measurements, a detailed discussion is given of the methods used for normalization of the cross sections.

20626 Measurement of the ultrashort bond length in He_2^{++}. Belkacem, A. (Argonne National Laboratory, Argonne, Illinois 60439 (US)); Kanter, E.P.; Mitchell, R.E.; Vager, Z.; Zabransky, B.J. *Physical Review Letters (USA),* 63(23): 2555-2558 (4 Dec 1989). DOE Contract W-31-109-ENG-38.

Coulomb explosion experiments have been carried out on both the dihelium cation He_2^+ and the corresponding doubly charged molecule He_2^{++} yielding bond-length distributions for each species. These measurements provide the first experimental evidence for the bond length of He_2^{++}. The most probable value of the measured bond-length distribution is 0.75±0.2 A. We also determine the lifetime to be longer than 5 μsec. This demonstrates the suitability of the Coulomb explosion method to the study of structures of short-lived, highly reactive, rare, or otherwise exotic molecules.

20627 Quasiatomic contributions to molecular-scattering form factors. Cavagnero, M. (Department of Physics and Astronomy, The University of Nebraska-Lincoln, Lincoln, Nebraska 68588-0111 (US)). *Physical Review [Section] A: General Physics (USA),* 40(11): 6199-6205 (1 Dec 1989).

The scattering form factors for excitation of H_2^+ in fast collisions are calculated in a sequence of approximations revealing their dependence on details of the initial- and final-state wave functions. Each approximate calculation is compared directly to the "exact" results obtained with separable, fixed-nuclei wave functions. Even for interproton separations larger than those for which the united-atom limit applies, the quasiatomic character of the final-state orbital dominates transition amplitudes to low-lying dissociative states. Possible applications to molecular dissociation by charged-particle impact at high energies are considered.

20628 Uncorrelated transfer excitation collisions at high energies. Hahn, Y. (Department of Physics, University of Connecticut, Storrs, Connecticut 06268 (US)); Ramadan, H. *Physical Review [Section] A: General Physics (USA),* 40(11): 6206-6209 (1 Dec 1989).

A new mode of transfer excitation (TE) process in high-energy ion-atom collisions is analyzed in which two or more electrons in the target system are involved incoherently in the excitation of the projectile ion and electron transfer. This uncorrelated TE mode (UTE) is shown to resolve the long-standing discrepancy in the high-energy tail of the resonant TE (RTE) cross section in the $Nb^{31+}+H_2$ collisions, and explains satisfactorily the recent experimental studies of the system $F^{6+}+H_2$ by Schulz *et al.* [Phys. Rev. Lett. 62, 1738 (1989)] for the uncorrelated transfer excitation followed by x-ray decay plus RTEX, involving radiative decay to a singly excited state, and of the low-lying states of F^{6+} with He by Zouros *et al.* [Phys. Rev. Lett. 62, 2261 (1989)] for the UTE involving Auger decay.

20629 Hyperfine structures in ^{167}Er II: Measurements of high $4f^{12}5d$ levels and *ab initio* multiconfiguration Dirac-Fock calculations. Andersen, L.U.A. (Institute of Physics, University of Aarhus, DK-8000 Aarhus C, Denmark (DK)); Childs, W.J.; Nielsen, U.; Poulsen, O. *Physical Review [Section] A: General Physics (USA),* 40(11): 6281-6285 (1 Dec 1989).

Hyperfine-structure measurements in high $4f^{12}5d$ metastable levels of ^{167}Er II have been carried out to supplement earlier data on the low $4f^{12}6s$ levels. *Ab initio* multiconfiguration Dirac-Fock (MCDF) calculations have been performed, and the effects of core excitations and configuration interaction have been investigated. While good agreement between experiment and calculation was found for the low 6*s* levels, a less clear interpretation emerges from the higher 6*d* levels. This points directly to the problems in the MCDF scheme in understanding the effects of core excitation and configuration interaction.

20630 State-selective observation of resonant transfer excitation in collisions of F^{6+} with He and H_2 targets. Zouros, T.J.M. (J. R. Macdonald Laboratory, Kansas State University, Manhattan, Kansas 66506 (US)); Lee, D.H.; Richard, P.; Sanders, J.M.; Shinpaugh, J.L.; Varghese, S.L.; Karim, K.R.; Bhalla, C.P. *Physical Review [Section] A: General Physics (USA),* 40(11): 6246-6250 (1 Dec 1989).

The $F^{5+}(1s2s2p^2)$ ^{3}D and ^{1}D states formed by transfer excitation (TE) in 4.75–33.25-MeV collisions of Li-like $F^{6+}(1s^22s)$ with He and H_2 targets were studied using 0° Auger-electron spectroscopy. The TE cross sections for these states showed resonances around 20 MeV with an energy dependence well described by the resonant TE impulse approximation. Resonance excitation cross sections were extracted and found to be about 2.2 to 3.2 times larger than theory.

20631 Distorted-wave calculations of dielectronic recombination for C^{3+} and O^{5+} in small electric fields. Griffin, D.C. (Department of Physics, Rollins College, Winter Park, Florida 32789 (USA)); Pindzola, M.S.; Krylstedt, P. *Physical Review [Section] A: General Physics (USA),* 40(11): 6699-6701 (1 Dec 1989).

The dielectronic recombination cross sections associated with the $2s \rightarrow 2p$ transition in Li-like carbon and oxygen ions in the presence of small electric fields have been calculated in the distorted-wave approximation. By convoluting the product of the electron velocity and the theoretical cross section with the experimental velocity distribution, we compare our calculations with recent measurements of high-resolution recombination rates $\langle v\sigma(v)\rangle$ by Andersen *et al.* With the exception of the magnitude of the low-energy peak due to the $2p4l$ resonances, the agreement between experiment and theory is excellent in C^{3+} for a field in the interaction region of just over 3 V/cm. In the case of O^{5+}, however, there is good agreement between experiment and theory for the low-Rydberg states, but there appear to be discrepancies between the measured rates and the theoretical rates for the high-Rydberg states, where the effects of fields are important.

20632 Deuterium molecule in the presence of electronic charge concentrations: Implications for cold fusion. Hassam, A.B. (Department of Physics and Astronomy, Laboratory for Plasma Research, University of Maryland, College Park, Maryland 20742 (USA)); Dharamsi, A.N. *Physical Review [Section] A: General Physics (USA),* 40(11): 6689-6691 (1 Dec 1989).

We examine semiclassically the reduction in bond length of the deuterium molecule when it forms astride a localized electronic charge concentration. For the types of charge concentration generally expected in the valence shells of high-Z atoms, bond-length reductions of several times over the vacuum length are suggested. Implications for cold nuclear fusion are discussed.

20633 Systematics of autoionization widths of doubly excited states of atoms. Chen, Z. (Department of Physics, Kansas State University, Manhattan, Kansas 66506 (US)); Lin, C.D. *Physical Review [Section] A: General Physics (USA),* 40(11): 6712-6715 (1 Dec 1989).

We analyze the autoionization widths of doubly excited states of two-electron atoms using the $(K,T)^A$ classification scheme introduced previously. It is shown that the widths of all the states along each truncated rotor series are comparable except for the last two states. This novel systematics is interpreted qualitatively in terms of the molecular or the correlated motion of the two electrons, except for the last two states which are explained in terms of the independent-electron model.

20634 Autoionization in atomic chlorine: Comparison of theories and experiment. Ruscic, B. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439 (US)); Berkowitz, J. *Physical Review [Section] A: General Physics (USA),* 40(11): 6716-6718 (1 Dec 1989). DOE Contract W-31-109-ENG-38.

High-resolution spectra (0.07 and 0.14 A, full width at half-maximum) are presented for the region between 860 and 918 A of the photoionization spectrum of atomic chlorine. Comparison is made with several many-body theories. Significant disagreement with theory is found, particularly with the widths and profiles of the sharp autoionizing resonances.

20635 K-shell photoabsorption of the N_2 molecule. Chen, C.T. (AT&T Bell Laboratories, Murray Hill, New Jersey 07974 (US)); Ma, Y.; Sette, F. *Physical Review [Section] A: General Physics (USA),* 40(11): 6737-6740 (1 Dec 1989).

The K-shell photoabsorption spectrum of the N_2 molecule, recorded with unprecedented energy resolution and statistical accuracy, reveals several new Rydberg transitions and double-excitation states. The nearly identical term values, vibrational frequencies and internuclear separations of the 1s-excited states of N_2 and of the 2π-excited states of NO, allow for a complete peak assignment for the N_2 Rydberg series and strongly support both the core-hole localization picture and equivalent-core model. Subtle differences are related to the final-state charge distribution in the vicinity of the nuclei and to the bonding character of the valence orbitals.

20636 Strong electron correlations and anomalous electron capture. Omar, G. (Department of Physics, Ain Shams University, Abbassia, Cairo, (Egypt)); Moussa, A.H.; Hahn, Y. *Physical Review [Section] A: General Physics (USA),* 40(11): 6709-6711 (1 Dec 1989).

The resonant electron-capture process is studied for the lightly charged ions of the K isoelectronic sequence with 19 electrons, where the inversion of the ground-state configuration takes place due to strong electron-electron correlation. An anomaly in the capture cross section is found around Sc^{2+}. The usual separation of the dielectronic recombination process into the intra- and intershell excitation transitions is no longer meaningful for these ions.

20637 Calculation of K-shell ionization cross sections by charged particles in the distortion approximation using pseudostates. Mukoyama, T. (Institute for Chemical Research, Kyoto University, Uji, Kyoto, 611 Japan (JP)); Lin, C.D. *Physical Review [Section] A: General Physics (USA),* 40(12): 6886-6891 (15 Dec 1989).

Cross sections for K-shell ionization by charged particles have been calculated within the framework of the impact-parameter formalism using the distortion approximation. The continuum wave functions are represented by pseudostates. It is confirmed that the pseudostate wave function can well reproduce the shape of the continuum wave function for low-energy electrons. The calculated total K-shell ionization cross sections for a number of ion-atom collision systems are shown to be in good agreement with the experimental results. For protons on copper, the ionization probabilities as a function of impact parameter are also found to agree with the measured values. The present results indicate that the distortion approximation using pseudostates is very useful in the study of K-shell ionization cross sections over a large range of ion-atom collision systems.

20638 Dielectronic recombination for C VI, and O VII, VII. Bellantone, R. (Department of Physics, University of Connecticut, Storrs, Connecticut 06269 (US)); Hahn, Y. *Physical Review [Section] A: General Physics (USA),* 40(12): 6913-6920 (15 Dec 1989).

Dielectronic recombination (DR) cross sections and rate coefficients for the H-like and He-like C and O ions are calculated in the zero-field, zero-density limit. The peak rates are approximately $(1.2–1.6)\times10^{-12}$ cm^3/sec for all four ions. For the H-like ions, the contribution to total rates from high Rydberg states ($n\geq6$) is found large, accounting for nearly one-half of the total rates. Agreements with earlier estimates are at a $\pm5\%$ level. For the He-like ions, the high-Rydberg-state contribution is strongly suppressed because of the extra Auger channel which opens up at n=5–7. Agreement with previous calculations is again at a 5% level. The DR cross sections for the initial metastable states of the He-like ions are also estimated for a few low-lying resonance states near the DR threshold. The cross section for the $2s\ ^1S\rightarrow1s2p\ ^1P+nl$ excitation capture is found to be very large.

20639 Semiempirical specification of singlet-triplet mixing angles, oscillator strengths, and g factors in $nsn'l$, $nsn'p^5$, np^2, and np^4 configurations. Curtis, L.J. (Department of Physics and Astronomy, University of Toledo, Toledo, Ohio 43606 (US)). *Physical Review [Section] A: General Physics (USA),* 40(12): 6958-6968 (15 Dec 1989).

Methods are presented for determining singlet-triplet mixing angles from measured energy-level data in two-valence electron systems, and for utilizing these mixing angles to specify $E1$ and $M1$ oscillator strengths and magnetic g factors from LS coupling and hydrogenic formulas and from data obtained in single-valence electron systems. These methods are tested through studies of line strengths in the He, Mg, Ne, Si, and S isoelectronic sequences and of g factors in the Kr and Pb atoms.

20640 Two-photon resonant multiphoton ionization and stimulated emission in krypton and xenon. Miller, J.C. (Chemical Physics Section, Health and Safety Research Division, Oak Ridge National Laboratory, P.O. Box 2008, Oak Ridge, Tennessee 37831-6125 (US)). *Physical Review [Section] A: General Physics (USA),* 40(12): 6969-6976 (15 Dec 1989). DOE Contract AC05-84OR21400.

Forward- and backward-directed, stimulated emissions have been observed following two-photon pumping of the 5p states of krypton and the 6p', 7p, 8p, and 4f states of xenon. Multiphoton ionization spectra are also obtained and compared with the photon-detected excitation spectra. In krypton coherent emissions from the 5p states to the 5s are observed, and for xenon many $p\rightarrow s$, $d\rightarrow p$, and $f\rightarrow d$ cascade emissions are observed. By analogy to the well-studied alkali-metal and alkaline-earth examples, the emissions are assigned as amplified spontaneous emission. Several intensity anomalies in the xenon $p\rightarrow s$ emissions are not understood at present. Interference effects due to coherent cancellation between competing excitation pathways may be occurring.

20641 K-shell photoionization of beryllium. Saha, H.P. (Department of Physics, University of Central Florida, Orlando, Florida 32816 (US)); Caldwell, C.D. *Physical Review [Section] A: General Physics (USA),* 40(12): 7020-7025 (15 Dec 1989).

The numerical multiconfiguration Hartree-Fock method is used to study in detail the photoionization of atomic beryllium near the 1s threshold. Electron correlation effects, which are found to be very important in the K-shell partial photoionization cross section, have been taken into account very accurately through the configuration-interaction procedure. The present results are compared with

experimental measurements of the relative contributions of the three major ionization channels and are found to be in excellent agreement. The existence of the principal resonances reported by the experiment has been confirmed and assignments made to these contributions based on accurate energy calculations.

20642 Theory of resonant multiphoton ionization of krypton by intense ultraviolet laser radiation. Tang, X. (Department of Physics, University of Southern California, Los Angeles, California 90089-0484 (USA)); Lambropoulos, P.; L'Huillier, A.; Dixit, S.N. *Physical Review [Section] A: General Physics (USA),* 40(12): 7026-7030 (15 Dec 1989).

We present a theoretical interpretation of the experimental results on three-photon-resonant four-photon ionization of Kr reported by Landen, Perry, and Campbell [Phys. Rev. Lett. 59, 2558 (1987)] and Perry and Landen [Phys. Rev. A 38, 2815 (1988)]. Our calculations are based on multichannel quantum-defect theory combined with a density-matrix formalism describing the spatiotemporal development of the process. We obtain good agreement with the data, which even at intensities as high as 10^{14} W/cm^2 show the imprint of the underlying atomic structure.

20643 Anticusp and binary peak structures in the electronic spectra arising from proton- and antiproton-helium collisions. Reinhold, C.O. (Department of Physics and Laboratory for Atomic and Molecular Research, University of Missouri-Rolla, Rolla, Missouri 65401 (US)); Schultz, D.R. *Physical Review [Section] A: General Physics (USA),* 40(12): 7373-7376 (15 Dec 1989).

The spectra of electrons ejected in collisions of protons and antiprotons with helium at impact energies of 100 and 500 keV are reported and compared. These calculations extend recent studies of the electronic spectra by means of the classical-trajectory Monte Carlo method to consider more energetic ejected electrons. Specifically, these new calculations exhibit the well-known binary peak, around which protons and antiprotons are shown to yield similar results. On the other hand, as predicted by quantum-mechanical distorted-wave approximations, a clear dip or anticusp is found in the electronic spectra produced by antiproton impact at electron velocities close to the projectile velocity, unlike the enhancement or cusp found for proton impact. Our results are consistent with simple dynamical mechanisms that reflect the two-center nature of the collision.

6404 Fluid Physics

Refer also to citation(s) 19908, 20086, 20225, 20251, 20252, 20253, 20323, 20829, 20939, 20940, 21014, 21018, 21024, 21028, 21043, 21047

20644 (DOE/ER/13548–T1) **[Statistical modeling studies of turbulent reacting flows]: Progress report.** Dwyer, H.A. California Univ., Davis, CA (USA). Dept. of Mechanical Engineering. 12 Mar 1987. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract FG03-86ER13548. Order Number DE90007294. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This paper discusses the study of turbulent wall shear flows, and we feel that this problem is both more difficult and a better challenge for the new methods we are developing. Turbulent wall flows have a wide variety of length and time scales which interact with the transport processes to produce very large fluxes of mass, heat, and momentum. At the present time we have completed the first calculation of a wall diffusion flame, and we have begun a velocity PDF calculation for the flat plate boundary layer. A summary of the various activities is contained in this report.

20645 (EUR-CEA-FC–1372) **Analysis of the magnetohydrodynamic equations and study of the nonlinear solution bifurcations.** Morros Tosas, J. Aix-Marseille-1 Univ., 13 - Marseille (France); Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. May 1989. 162p. (In French). Available from NTIS (US Sales Only), PC A08/MF A01.

The nonlinear saturation of a plasma magnetohydrodynamic instabilities is studied, by means of a bifurcation theory. The work includes: an accurate mathematical method to study the MHD equations, in which the physical content is clear; and the study of the nonlinear solutions of the branch bifurcations, applied to different unstable plasma models. A scalar function representation is proposed for the MHD equations. This representation is characterized by a reference steady magnetic field and by a velocity field, which allow to write the equations for the scalar functions. An approximation method, leading to the obtention of the reduced equations applied in the instability study, is given. The cylindrical or toroidal plasmas are studied by using the nonlinear solutions bifurcation. Concerning the cylindrical plasma, the representation leads to a reduced system which enables the analytical calculations: two different steady bifurcation solutions are obtained. In the case of the toroidal plasma, an appropriate reduced equations system, is obtained. A qualitative approach of the Kink-type steady solution bifurcation, in a toroidal geometry, is performed.

20646 (LA-UR–90-539) **Bose condensate in superfluid ^{4}He and momentum distributions by deep inelastic scattering.** Silver, R.N. (Los Alamos National Lab., NM (USA)); Sokol, P.E. Los Alamos National Lab., NM (USA). [1989]. 30p. Sponsored by Argonne National Laboratory; U.S. DOE Management & Administration; National Science Foundation. DOE Contract W-7405-ENG-36. (CONF-8911150–2: 6. international conference on recent progress in many body theories, Arad (Israel), 6-10 Nov 1989). Order Number DE90007541. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

There are several reasons for the high interest in the recent experimental and theoretical progress in understanding deep inelastic neutron scattering from liquid ^{4}He: it tests the fundamental London hypothesis of a connection between superfluidity and Bose condensation; it provides a quantitative test of ab-initio calculational methods for all systems with strong correlations which are the focus of current quantum many-body research; and it establishes the range of validity of deep inelastic scattering as a method for measuring momentum distributions. In this paper we introduce the concepts of impulse approximation in more detail, we describe recent progress in the theory for final state corrections to the impulse approximation, we present quantitative predictions for neutron scattering experiments, we compare with recent high energy pulsed neutron source experiments on liquid ^{4}He by P. Sokol and colleagues as well as other attempts to extract the Bose condensate fraction from the neutron scattering data, and we discuss the implications of this progress for future momentum distribution experiments in other systems such as liquid ^{3}He and quasi-elastic electron nucleus scattering. 42 refs., 23 figs.

20647 (ORNL–6516) **Modeling convective Marangoni flows with void movement in the presence of solid-liquid phase change.** Drake, J.B. Oak Ridge National Lab., TN (USA). Jan 1990. 34p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90006474. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report describes a numerical method for solving heat conduction and fluid flow problems that involve phase changes. The complications arising from materials with different liquid and solid densities are discussed, and approximations are developed for Marangoni stress, curvature dependent pressure jumps and void movement. Applications to both O-g and 1-g environments are discussed. The fluid flow algorithm is a variant of the projection method for incompressible liquids. A control volume method of discretization along with an appropriate formulation of the conservation laws for mass and momentum yield a weak form which applies throughout the computational region. In this form no fronts between liquid and solid or between liquid and void are explicitly tracked, though the position of the fronts is readily determined from the solution field variables. The discrete equations use an implicit Crank-Nicolson method. The non-linear implicit equations are solved using a Newton method with an Approximate Factorization method for the iterative solution of the Jacobian system. 31 refs., 8 figs.

20648 (SFB-210/A–42, pp. 193-213) **Flow mechanics measurement criteria for flocculation reactors.** Hahn, H.H.; Klute, R.; Hartmann, K.H.; Hoffmann, E. Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke. Mar 1988. (In German). In *Work and result report of Special Research Area 210 for the years*

1985-1987. Available from Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke. Available from Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke.

The target of the project is the formulation of dimensioning instructions/criteria for flocculation reactors. This project is directly connected with the two part projects D 1/2 worked on during the first period, which together represent the basis for the SFB 210 project 'Practical dimensioning nomogram for combined flocculation and separation reactors' and 'Flow mechanics dimensioning basis for reactors for the chemical conditioning of sludge'. The relevant developments for achieving this main target are explained. (orig./KW).

20649 Probability distribution of a stochastically advected scalar field. Chen, H. (Center for Nonlinear Studies, Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (USA)); Chen, S.; Kraichnan, R.H. *Physical Review Letters (USA),* 63(24): 2657-2660 (11 Dec 1989).

A systematic method is outlined for constructing workable approximations to the joint probability distribution $P(\psi,\xi)$ of amplitude ψ and spatial gradient ξ of an active or passive scalar field that is advected by a prescribed isotropically distributed stochastic velocity field and subjected to molecular diffusion. $P(\psi,\xi)$ is sampled along fluid-element paths, and closure is obtained by taking a multivariate-Gaussian reference field $\psi_0(\mathbf{x})$ and distorting it locally in x space so that it exhibits the current $P(pxi,\xi)$.

20650 Variational limits on the Helmholtz free energy of simple fluids. Boercker, D.B. (Lawrence Livermore National Laboratory, University of California, Livermore, California 94550 (US)); Young, D.A. *Physical Review [Section] A: General Physics (USA),* 40(11): 6379-6383 (1 Dec 1989). DOE Contract W-7405-ENG-48.

Accurate radial-distribution functions obtained from a thermodynamically consistent integral equation are used to calculate upper and lower bounds to the Helmholtz free energies of several inverse-power potential fluids and the Lennard-Jones fluid. Comparisons with results from Monte Carlo simulations indicate that the true free energies are tightly bracketed by the variational bounds. In addition, the simulations agree with the arithmetic mean of the limits near melt to within about $0.03Nk_BT$ for inverse power fluids and about $0.06Nk_BT$ for Lennard-Jones fluids. These results indicate that it is possible to obtain accurate free energies very efficiently by the variational method.

20651 Elimination of hysteresis in a system of coupled Ginzburg-Landau equations. Sullivan, T.S. (Center for Nonlinear Studies, Mail Stop B258, Los Alamos, National Laboratory, Los Alamos, NM (USA)); Deissler, R.J. *Physical Review [Section] A: General Physics (USA),* 40(11): 6748-6751 (1 Dec 1989).

We numerically study the effect of a stabilizing quintic term and a destabilizing cubic term in the coupled Ginzburg-Landau equations that describe the onset of traveling-wave convection in binary fluid mixtures. We present bifurcation diagrams which show that for large enough group velocity and coupling between the counter-propagating traveling waves, the expected hysteresis at onset is not present. We also show how a measure of the convected heat transport and its period vary with scaled Rayleigh number. While this model can explain certain features of recent experiments, a number of difficult issues remain.

20652 Extending hydrodynamics via the regularization of the Chapman-Enskog expansion. Rosenau, P. (Department of Mechanical Engineering, Technion, Israel Institute of Technology, Haifa 32000, Israel (IL)— Center for Nonlinear Studies, Los Alamos National Laboratory, Mail Stop B258, Los Alamos, New Mexico 87545). *Physical Review [Section] A: General Physics (USA),* 40(12): 7193-7196 (15 Dec 1989).

A regularization procedure of the Chapman-Enskog expansion is introduced. It extends the hydrodynamical description into higher gradients domains. This was intended but never accomplished satisfactorily by the Burnett equations. The resulting macroscopic system formally has the same form (and complexity) as the Navier-Stokes equations, with the new transport coefficients being wavelength dependent. It reduces in the long-wavelength limit to the Burnett equations. In agreement with experimental evidence, strong shock layers are narrower in comparison with the predictions of the Navier-Stokes theory.

20653 Onset of secondary flow in the modulated Taylor-Couette system. Wu, X. (Department of Physics and Center for Nonlinear Dynamics, University of Texas at Austin, Austin, Texas 78712 (US)); Swift, J.B. *Physical Review [Section] A: General Physics (USA),* 40(12): 7197-7201 (15 Dec 1989).

The critical Reynolds number for the linear instability of primary flow is calculated for a Taylor-Couette system in which the rotation rate of either cylinder is modulated sinusoidally in time. The method used is based on that of Hall [J. Fluid Mech. 67, 29 (1975)] and is restricted to small amplitudes of modulation but allows for a finite gap. For the case of outer-cylinder modulation, we find that the critical Reynolds number is larger than that for the unmodulated system, while, if the inner cylinder is modulated, it is smaller.

20654 Flow of a surfactant across a thin liquid film wetting a solid substrate. Peng, J.B. (Department of Physics and Astronomy and Materials Research Center, Northwestern University, Evanston, Illinois 60208 (US)); He, S.X.; Dutta, P.; Ketterson, J.B. *Physical Review [Section] A: General Physics (USA),* 40(12): 7421-7423 (15 Dec 1989).

Transfer of a monolayer (valinomycin) between two Langmuir troughs via an interconnecting glass "bridge" has been observed when there is a difference between the monolayer pressures in the two troughs. Assuming that the transfer occurs over the surface of the thin film of water that wets the "bridge," the transfer rate can be used to estimate the thickness of the liquid film. The thickness thus determined may be used to determine the retarded van der Waals (Hamaker) constant associated with the interaction of the film with the underlying substrate.

6450 High Energy Physics

Refer also to citation(s) 19660, 20589

20655 (ANL-HEP-TR–89-121) **Argonne National Laboratory High Energy Physics Division semiannual report of research activities, January 1, 1989–June 30, 1989.** Argonne National Lab., IL (USA). [1989]. 88p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. Order Number DE90007605. Available from NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

This paper discuss the following areas on High Energy Physics at Argonne National Laboratory: experimental program; theory program; experimental facilities research; accelerator research and development; and SSC detector research and development.

20656 (DOE/ER–0435) **The ultimate structure of matter: The high energy physics program from the 1950s through the 1980s.** USDOE Office of Energy Research, Washington, DC (USA). Feb 1990. 43p. Sponsored by U.S. DOE Energy Research. Order Number DE90005682. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This discusses the following topics in High Energy Physics: The Particle Zoo; The Strong and the Weak; The Particle Explosion; Deep Inside the Nucleon; The Search for Unity; Physics in Collision; The Standard Model; Particles and the Cosmos; and Practical Benefits.

20657 (DOE/ER/40509–1) **Research accomplishments and future goals in particle physics.** Boston Univ., MA (USA). 5 Jan 1990. 139p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40509. Order Number DE90007296. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

This document presents our proposal to continue the activities of Boston University researchers in eight projects in high energy physics research: study of high energy electron-positron annihilation, using SLD detector at SLAC. Development of integrated transition radiation detection and tracking for an SSC detector; Development of new concepts for particle accelerator components, including design and prototyping of high-precision electrostatic and magnetic elements; Development of a new underground detector facility in the Gran Saso Laboratory in Italy to search for magnetic

monopoles and to study astrophysical muons and neutrinos; Search for proton decay and neutrinos from point astrophysical sources, and the study of cosmic ray muons and neutrinos in the IMB detector; Study of theoretical particle physics, including lattice gauge theories, string theories, phenomenology of the Standard Model and its extensions, and application of particle physics concepts to the early universe, cosmology and astrophysics, as well as the extension of these techniques into computational physics; Preparation of an experiment to measure the anomalous magnetic moment of the muon in a new superconducting storage ring and detector system at BNL; Fabrication (with M.I.T. and Princeton) of the BGO endcaps and associated tracking chambers for the L3 detector at LEP. Development of a central tracker for the SSC; and This new tasks requests support for research, development, and beam testing of a prototype SSC calorimeter featuring a tower geometry and composed of lead alloy and scintillating fibers.

20658 (IKF–48) **IKF annual report 1988.** Frankfurt Univ. (Germany, F.R.). Inst. fuer Kernphysik. 1989. 148p. (In German). Order Number DE90753181. Available from NTIS (US Sales Only), PC A07/MF A01.

The annual report of 1988 gives a survey of the following category of themes: nuclear physics, atom physics, nuclear methods, nuclear solid-state physics and developments of machines. Apart from the use of its own Van de Graaff accelerators the institute takes part in joint ventures in research, for example with the GSI (Association for Heavy-Ion Research) in Darmstadt. (DG).

20659 (UFTP-EXP–89-1) **UFMulti: A new parallel processing software system for HEP [High Energy Physics].** Avery, P.; White, A. Florida Univ., Gainesville, FL (USA). Dept. of Physics. [1989]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-86ER40272. (CONF-890415–12: Computing in high energy physics, Oxford (UK), 10-14 Apr 1989). Order Number DE90006914. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

UFMulti is a multiprocessing software package designed for general purpose High Energy Physics applications, including physics and detector simulation, data reduction and DST physics analysis. The system is particularly well suited for installations where several workstations or computers are connected through a Local Area Network (LAN). The initial configuration of the software is currently running on VAX/VMS machines with a planned extension to ULTRIX, using the new RISC CPUs from Digital, in the near future.

6451 Particle Interactions and Properties - Experimental

Refer also to citation(s) 20699

20660 (BNL–43818) **Hadron production in relativistic heavy ion interactions and the search for the quark-gluon plasma.** Tannenbaum, M.J. Brookhaven National Lab., Upton, NY (USA). Dec 1989. 77p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-891269–2: 1989 winter school on quark-gluon plasma, Puri (India), 5-16 Dec 1989). Order Number DE90007351. Available from NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

The course starts with an introduction, from the experimentalist's point of view, of the challenge of measuring Relativistic Heavy Ion interactions. A review of some theoretical predictions for the expected signatures of the quark gluon plasma will be made, with a purpose to understand how they relate to quantities which may be experimentally measured. A short exposition of experimental techniques and details is given including charged particles in matter, momentum resolution, kinematics and Lorentz Transformations, calorimetry. Principles of particle identification including magnetic spectrometers, time of flight measurement. Illustrations using the E802 spectrometer and other measured results. Resolution smearing of spectra, and binning effects. Parent to daughter effects in decay, with $\pi^0 \rightarrow \gamma\,\gamma$ as an example. The experimental situation from the known data in p – p collisions and proton-nucleus reactions is reviewed and used as a basis for further discussions. The "Cronin Effect" and the "Seagull Effect" being two arcana worth noting. Then, selected experiments from the BNL and CERN heavy ion programs are discussed in detail. 118 refs., 45 figs.

20661 (DOE/ER/10690–8) **Participation in the ARGUS experiment at the DORIS Collider at DESY, Hamburg, Germany and participation in the AMY experiment at the Tristan Collider in Tsukuba, Japan: Progress report, January 1–December 31, 1987.** Darden, C.; Rosenfeld, C. South Carolina Univ., Columbia, SC (USA). Dept. of Physics and Astronomy. Jan 1990. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AS09-80ER10690. Order Number DE90007083. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper discusses electron-positron annihilation at high energy. This work began in 1977 with the DASP II Collaboration at the DORIS storage ring of the DESY Laboratory in Hamburg. The collaboration's first publication reported the observation of the narrow Υ resonance at 9.46 GeV, confirming the original observation of this state in proton-nucleus collisions at Fermilab. To enable investigations of the Υ family of resonances the DORIS ring was rebuilt for reliable operation at the top of its energy range where the Υ states are accessible. In addition a new detector, ARGUS, was installed at one interaction region. This paper also discusses the AMY Collaboration which investigates electron-positron annihilation at energies from 50 to 65 GeV. The AMY detector is in the beam of the TRISTAN collider of the KEK Laboratory in Tsukuba, Japan.

20662 (DOE/ER/10690–9) **Participation in the ARGUS experiment at the DORIS collider at DESY, Hamburg, Germany and participation in the AMY experiment at the TRISTAN collider in Tsukuba, Japan: Progress report, January 1–December 31, 1988.** Darden, C.; Rosenfeld, C. South Carolina Univ., Columbia, SC (USA). Dept. of Physics and Astronomy. Jan 1990. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AS09-80ER10690. Order Number DE90007084. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This paper discusses studies on the interactions of electrons and positrons in the upsilon energy range and the energy range of the tristan ring at KEK. (LSP)

20663 (DOE/ER/10690–10) **Participation in the AMY experiment at the TRISTAN collider in Tsukuba, Japan and participation in Fermilab Experiment E-789: Progress report, January 1–December 31, 1989.** Darden, C.; Rosenfeld, C. South Carolina Univ., Columbia, SC (USA). Dept. of Physics and Astronomy. Jan 1990. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AS09-80ER10690. Order Number DE90007082. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This paper discusses two-body decays of b-flavored mesons and studies electron-positron interactions using the triston collider at KEK. (LSP)

20664 (FNAL/C–90/14-E) **A new measurement of CP violation parameter ε'/ε.** Yamanaka, Taku. Fermi National Accelerator Lab., Batavia, IL (USA). Jan 1990. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. (CONF-890903–12: International Europhysics conference on high-energy physics, Madrid (Spain), 7-14 Sep 1989). Order Number DE90006812. Available from NTIS, PC A02/MF A01; OSTI; INIS.

The E731 experiment at Fermilab has measured the CP violation parameter $\mathrm{Re}(\varepsilon'/\varepsilon)$ in $K_{L,S} \rightarrow \pi\pi$ decay. Four decay modes were collected simultaneously to reduce systematic errors. The result is $\mathrm{Re}(\varepsilon'/\varepsilon) = -0.0005 \pm 0.0014$ (stat.) $\pm$ 0.0006 (syst.), and gives no evidence for direct CP violation. 7 refs., 3 figs., 1 tab.

20665 (LA-UR–90-134) **MEGA: An experiment to search for $\mu \rightarrow e\gamma$ at the level of 10^{-13}.** Mischke, R.E. Los Alamos National Lab., NM (USA). [1989]. 12p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract W-7405-ENG-36. (CONF-8911165–2: International seminar on intermediate energy physics (INES-89), Moscow (USSR), 27-30 Nov 1989). Order Number DE90008635. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This report describes the status of the MEGA experiment, which is a search for the decay $\mu \rightarrow e\gamma$ with a branching ratio sensitivity of approximately 10^{-13}. The observation of this decay would contradict the empirically established rule of lepton family number

conservation and would indicate the existence of physics outside the standard model of electroweak interactions. The experimental design employs highly modular, fast detectors, state-of-the-art electronics, and a staged trigger with online filters. The detectors are contained in a 15 kG solenoidal field produced by a superconducting magnet. Positrons are confined to the central region and are measured by a set of thin MWPCs. Photons are measured by one of four layers of pair spectrometers in the outer region. Most aspects of the detector design have been validated in engineering runs; data taking will begin in 1990 with the electron arm and one pair spectrometer layer installed. 9 refs., 1 fig.

20666 (SLAC–328, pp. 47-82) **Prospects for physics at e^+e^- linear colliders.** Feldman, G.J. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jan 1988. (CONF-870821–: SLAC summer institute on particle physics: looking beyond the Z, Stanford, CA (USA), 10-21 Aug 1987). In *Looking beyond the Z: Proceedings.* Order Number DE88011870. Available from NTIS, PC A04/MF A01.

About a year ago, Burton Richter established two committees at SLAC to begin work on a proposal for a high-energy linear e^+e^- collider. These three lectures and the two lectures by Mike Peskin will report on some of the work that has been done by these two committees. However, these reports should be considered unofficial and preliminary since neither committee has yet issued a report. All the conclusions drawn in these lectures are the authors and may differ from the conclusions the committees subsequently draw in their reports. In Section 2, the present thinking on high-energy e^+e^- linear colliders, is reviewed stressing those points that have consequences for detector design and physics analyses. Section 3 will discuss detector requirements. Sections 4 through 9 will discuss experimental aspects of the physics that can be done at these colliders: first the general physics environment, then a standard process, W^+W^- detection, and finally four examples of the discovery potential of these colliders - heavy quarks, heavy leptons, standard Higgs bosons, and charged Higgs bosons. These topics will constitute only a fraction of those that were studied by the Physics Committee. The conclusions of this study will be stated in Section 10. 23 refs., 40 figs., 18 tabs.

20667 (SLAC–328, pp. 365-374) **Status and first results of Brookhaven experiment 780: A search for $K_L^0 \to \mu \pm e$ and $K_L^0 \to e+e$.** Greenlee, H.B. (Yale Univ., New Haven, CT (USA)); Kasha, H.; Mannelli, E.; Mannelli, M.; Schaffner, S.; Schmidt, M.P.; Schwarz, C.B.; Adair, R.K.; Jastrzembski, E.; Larsen, R.C. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jan 1988. (CONF-870821–: SLAC summer institute on particle physics: looking beyond the Z, Stanford, CA (USA), 10-21 Aug 1987). In *Looking beyond the Z: Proceedings.* Order Number DE88011870. Available from NTIS, PC A04/MF A01.

The authors report on the progress of a search for the rare decays $K_L^0 \to \mu + e$ and $K_L^0 \to e+e$ underway at the Brookhaven National Laboratory AGS. Analysis of data collected in February and May of 1987 yields the preliminary limit: $BR(K_L^0 \to \mu+e)$, $BR(K_L^0 \to e+e) < 7 \cdot 10^{-9}$. Prospects are discussed for the running period scheduled to being in January of 1988. 12 refs., 7 figs.

20668 (SLAC–328, pp. 375-384) **A precision measurement of ϵ'/ϵ.** Wahl, H. (CERN, Geneva (Switzerland)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jan 1988. (CONF-870821–: SLAC summer institute on particle physics: looking beyond the Z, Stanford, CA (USA), 10-21 Aug 1987). In *Looking beyond the Z: Proceedings.* Order Number DE88011870. Available from NTIS, PC A04/MF A01.

In this talk the author presents a short introduction to the phenomenology of CP violation in the kaon system and to the current experimental status. He reports on the on-going activity at CERN to measure ϵ'/ϵ, including a preliminary result from this experiment. 22 refs., 9 figs., 3 tabs.

20669 (SLAC–328, pp. 521-536) **Recent results from AMY at TRISTAN.** McNeil, R. (Lousiana State Univ., Baton Rouge (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jan 1988. (CONF-870821–: SLAC summer institute on particle physics: looking beyond the Z, Stanford, CA (USA), 10-21 Aug 1987). In *Looking beyond the Z: Proceedings.* Order Number DE88011870. Available from NTIS, PC A04/MF A01.

Results are presented from the AMY detector at TRISTAN from 0.69 pb^{-1} of integrated luminosity at $\sqrt{s}$ = 50 GeV and 3.98 pb^{-1} at $\sqrt{s}$ = 52 GeV. The differential cross sections for the leptonic reactions $e^+e^- \to \mu^+\mu^-$, and $e^+e^- \to \tau^+\tau^-$ are presented as well as the measured value of R for e^+e^- annihilation into hadrons. In addition results are presented on the characteristics of the final state hadrons and inclusive leptons in the annihilation events and place limits on the production of new heavy quark flavors. 20 refs., 11 figs., 6 tabs.

20670 (SLAC–328, pp. 587-601) **Recent measurements of the B hadron lifetime.** Ong, R.A. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jan 1988. (CONF-870821–: SLAC summer institute on particle physics: looking beyond the Z, Stanford, CA (USA), 10-21 Aug 1987). In *Looking beyond the Z: Proceedings.* Order Number DE88011870. Available from NTIS, PC A04/MF A01.

Recent measurements of the B hadron lifetime from PEP and PETRA experiments are presented. These measurements firmly establish that the B lifetime is long ($\approx$ 1 psec), implying that the mixing between the third generation of quarks and the lighter quarks is much weaker that the mixing between the first two generations. 16 refs., 12 figs., 4 tabs.

20671 (SLAC–328, pp. 645-654) **Weak neutral currents and future Z mass measurements.** Marciano, W.J. (Brookhaven National Lab., Upton, NY (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jan 1988. (CONF-870821–: SLAC summer institute on particle physics: looking beyond the Z, Stanford, CA (USA), 10-21 Aug 1987). In *Looking beyond the Z: Proceedings.* Order Number DE88011870. Available from NTIS, PC A04/MF A01.

Several years ago, a collaboration was formed for the purpose of collecting and analyzing all neutral current data. The idea was to carefully scrutinize the experimental and theoretical uncertainties in those results and to consistently include effects of electroweak radiative corrections. That undertaking involved examining a great many diverse measurements which included (in approximate order of precision): deep-inelastic $\nu_\mu N$ scattering, $W^\pm$ and Z masses, eD scattering asymmetry, atomic parity violation, νe scattering, νp scattering, e^+e^- annihilation, μC scattering etc. The goals of the work were: (1) To test the standard $SU(2)_L \times U(1)$ model at the tree and quantum loop level. (2) Provide a precise determination of $\sin\theta_W$ which could, for example, be used to rule out or at least constrain various grand unified theories (GUTS). (3) Look for hints of new physics. In this talk, the author will outline some of the main results of that collective effort and discuss various implications. The topics chosen are radiative corrections, top quark mass bounds, grand unified theories (GUTS), and extra Z^1 boson constraints. 21 refs., 3 figs., 3 tabs.

20672 (SLAC–356) **A measurement of the resonance parameters of the neutral intermediate vector boson.** Nash, J.A. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jan 1990. 122p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. Order Number DE90008143. Available from NTIS, PC A07/MF A01; OSTI; INIS; GPO Dep.

This thesis presents a measurement of the Z^0 Boson resonance parameters. The measurement was performed at the Stanford Linear Collider using the Mark II detector. Based on a sample of 480 Hadronic and Leptonic decays, the mass is found to be 91.14 $\pm$ 0.12 GeV/c^2, the total width is $2.42\ ^{+0.45}_{-0.35}$ GeV, and the peak cross section for all Hadronic events, and for Muon and Tau events with $\cos\theta_{Thrust} < 0.65$ is 45 $\pm$ 4 nb. By constraining the visible width to the Standard Model value for 5 quarks and 3 charged leptons, and allowing the invisible width to be a parameter, the width to invisible decay modes is found to be 0.46 $\pm$ 0.10 GeV. Assuming this width comes from massless neutrinos, this measurement corresponds to 2.8 $\pm$ 0.6 neutrino species. This measurement sets an upper limit of 3.9 neutrino generations at the 95% confidence level, ruling out a fourth generation of Standard Model neutrinos at this level. 54 refs., 65 figs., 11 tabs.

20673 (SLAC-PUB–5145) **$s\bar{s}$ spectroscopy from the LASS [Large Aperture Superconducting Solenoid] spectrometer.** Aston, D.; Bienz, T.; Bird, F.; Dunwoodie, W.; Johnson, W.; Kunz, P.; Leith, D.; Levinson, L.; Ratcliff, B.; Schultz, D. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Dec 1989. 8p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract AC03-76SF00515. (CONF-8809218–4: 9. European symposium on antiproton-proton interactions and fundamental symmetries, Mainz (Germany, F.R.), 5-9 Sep 1988). Order Number DE90006461. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A brief summary is presented of results pertinent to $s\bar{s}$ spectroscopy derived from high statistics data on K^-p interactions obtained with the LASS spectrometer at SLAC. 21 refs., 10 figs.

20674 Semileptonic decays of B meson into charmed meson. Katayama, N. (Cornell Univ., Ithaca, NY (USA)). pp. 445 of Heavy quark physics. Drell, P.S.; Rubin, D.L. [eds.] [Cornell Univ., Ithaca, NY (USA). Lab. of Nuclear Studies] American Institute of Physics, New York, NY (US) (1989). (CONF-8906204–: International symposium on heavy quark physics, Ithaca, NY (USA), 13-17 Jun 1989).

Recent results on semileptonic decays of B meson into charmed meson using the CLEO detector at CESR are summarized. Ratios of the inclusive semileptonic branching fractions, $B(B^- \to D^0 X\ell^-\bar{\nu})$, $B(\bar{B}^0 \to D^+ X\ell^-\bar{\nu})$, and $B(\bar{B}^0 \to D^{*+} X\ell^-\bar{\nu})$ to the average B meson semileptonic branching fraction are reported. The branching fractions of the exclusive final states, $B^- \to D^0\ell^-\bar{\nu}$, $B^- \to D^{*0}\ell^-\bar{\nu}$, and $\bar{B}^0 \to D^{*+}\ell^-\bar{\nu}$ are measured. The ratio of $B(B^- \to D^{*0}\ell^-\bar{\nu})$ to $B(B^- \to D^0\ell^-\bar{\nu})$ and the polarization of the D^{*+} are obtained and compared with theoretical models. The value of $|V_{cb}|$ is calculated from the exclusive branching fractions for various models. Finally, the lifetime ratio of the charged and neutral B (τ^+/τ^0) is determined from the ratio of $B(B^- \to D^{*0}\ell^-\bar{\nu})$ to $B(\bar{B}^0 \to D^{*+}\ell^-\bar{\nu})$ to be $0.85 \pm 0.02_{-0.16}{}^{+0.22}$. 16 refs., 4 figs., 2 tabs.

20675 Exclusive semileptonic B decays to charm. Glaeser, R. (DESY, Hamburg (West Germany)). pp. 445 of Heavy quark physics. Drell, P.S.; Rubin, D.L. [eds.] [Cornell Univ., Ithaca, NY (USA). Lab. of Nuclear Studies] American Institute of Physics, New York, NY (US) (1989). (CONF-8906204–: International symposium on heavy quark physics, Ithaca, NY (USA), 13-17 Jun 1989).

Using the ARGUS detector at the e^+e^- storage ring DORIS II at DESY the author has investigated the exclusive decays $B^0 \to D^{*-}l^+\nu$ and $B^0 \to D^{-}l^+\nu$ and have determined the CKM matrix element of V_{cb}. By measuring the yields of $\bar{D}^0$, D^0, D^- and D^{*-} mesons originating from semileptonic $\bar{B}$ decays, the lifetime ratio of charged and neutral B mesons, $\tau(B^+)/\tau(B^0)$, is derived. 14 refs., 3 figs.

20676 Charmless B meson decays at CLEO. Procario, M. (Harvard Univ., Cambridge, MA (USA)). pp. 445 of Heavy quark physics. Drell, P.S.; Rubin, D.L. [eds.] [Cornell Univ., Ithaca, NY (USA). Lab. of Nuclear Studies] American Institute of Physics, New York, NY (US) (1989). (CONF-8906204–: International symposium on heavy quark physics, Ithaca, NY (USA), 13-17 Jun 1989).

The author has measured the lepton momentum spectra in semileptonic B meson decays using data taken with the CLEO detector at CESR. They find an excess of leptons in the region above that kinematically allowed for decays containing charm. Ascribing these leptons to charmless semileptonic decays yields of V_{ub}/V_{cb} of approximately 0.1. 12 refs., 2 figs., 1 tab.

20677 Fast pulsar in SN 1987A: Candidate for strange-quark matter. Glendenning, N.K. (Nuclear Science Division, Lawrence Berkeley Laboratory, One Cyclotron Road, Berkeley, California 94720 (US)). *Physical Review Letters (USA)*, 63(24): 2629-2632 (11 Dec 1989). DOE Contract AC03-76SF00098.

All known pulsar frequencies and masses can be accounted for by plausible neutron-star models with the exception of the new fast pulsar. To withstand its rotation frequency the central density of the star must be so high that the constituents cannot be individual hadrons. If strange-quark matter (u,d,s quarks) is the absolute ground state, a star of such matter can be stable against mass loss at the frequency of the new pulsar. An essential difference between neutron stars and strange stars is the binding force, gravity for ordinary stars, and confinement and gravity in the case of strange stars.

20678 Dimuon production in 800-GeV proton-nucleus collisions. Brown, C.N. (Fermilab, Batavia, Illinois 60510 (USA)); Cooper, W.E.; Finley, D.; Hsiung, Y.B.; Jonckheere, A.M.; Jostlein, H.; Kaplan, D.M.; Lederman, L.M.; Moreno, G.; Hemmi, Y. *Physical Review Letters (USA)*, 63(24): 2637-2640 (11 Dec 1989).

A measurement of continuum dimuon production in proton-copper collisions at 800-GeV incident energy is presented. The dimuons observed in this experiment cover the mass range from 6.5 to 18 GeV near y=0 in the proton-nucleon center-of-momentum frame. Scaling forms of the cross section for the continuum are compared with the results of other experiments in the context of the parton model and quantum chromodynamics. The present limitations of such scaling comparisons are discussed.

20679 Polarization in inclusive Λ and $\bar{\Lambda}$ production at large p_T. Lundberg, B. (Physics Department, University of Wisconsin, Madison, Wisconsin 53706 (US)); Handler, R.; Pondrom, L.; Sheaff, M.; Wilkinson, C.; Dworkin, J.; Overseth, O.E.; Rameika, R.; Heller, K.; James, C. *Physical Review [Section] D: Particles and Fields (USA)*, 40(11): 3557-3567 (1 Dec 1989).

A study of the inclusive polarization of Λ hyperons produced by 400-GeV/c protons incident on nuclear targets has been performed at Fermilab. The polarization **P** of the Λ has been mapped over a large range of x_F and p_T to good precision for p_T up to 3.8 GeV/c. The magnitude of the polarization at fixed x_F rises with p_T to a plateau at about 1 GeV/c, and the size of the plateau increases monotonically with x_F. The $\bar{\Lambda}$ were found to be unpolarized for p_T<2.4 GeV/c. A target-nucleus dependence for the Λ polarization has been observed.

20680 Heavy-quark production at Fermilab Tevatron Collider energies. Sarcevic, I. (Physics Department, University of Arizona, Tucson, Arizona 85721 (US)); Carruthers, P.; Gao, Q. *Physical Review [Section] D: Particles and Fields (USA)*, 40(11): 3600-3607 (1 Dec 1989).

We propose a way to test structure functions at low x by measuring the heavy-quark cross section at Fermilab Tevatron Collider energies. We show that the QCD calculation (through order $\alpha_s{}^3$) of the total cross section for the bottom- and top-quark pair cross section is very sensitive to the choice of the structure function at Collider energies. Comparison with the experimental data indicates that some choices of the structure functions seem to be preferred by the data. We illustrate how measurements of the bottom-quark pair cross section at Tevatron Collider energies should be able to make a clear distinction between different choices of the structure functions, therefore providing valuable information about the gluon structure function at low x. We find that the bottom-quark cross section at Collider energies is dominated by the gg initial subprocess, while the top-quark cross section is dominated by the contribution from the $q\bar{q}$ subprocess at low energies. At Tevatron energies this contribution becomes 30%, while the rest is due to the gg initial subprocess. We show that the ratio of the cross section calculated through order $\alpha_s{}^3$ to the one calculated through the order $\alpha_s{}^2$, the so-called K factor, is of order 3 for the bottom-quark cross section and of order 2 for the top-quark cross section at Tevatron energies. We also show that the theoretical uncertainty due to the choice of the structure function has a significant effect on the experimental lower limit of the top-quark mass.

20681 Importance of initial-state radiation to the search for the top quark at hadron colliders. Haim, D. (Physics Department, University of Illinois at Urbana-Champaign, 1110 West Green Street, Urbana, Illinois 61801 (US)). *Physical Review [Section] D: Particles and Fields (USA)*, 40(11): 3608-3612 (1 Dec 1989).

A study was performed on initial-state radiation in the process of heavy-top-quark production, at hadron colliders (both the Fermilab Tevatron and the Superconducting Super Collider). In particular, we studied events with the hard subprocesses $gg \to t\bar{t}$ and $q\bar{q} \to t\bar{t}$, with the subsequent semileptonic decay $t\bar{t} \to b\bar{b}+l^+l^-+$missing p_T. Using the Webber-Marchesini Monte Carlo program herwig, we produced 5000 events of this process, using top-quark masses of 100, 150, and 200 GeV. We find that in the process of $t\bar{t}$ production, when the top quark is heavier than the W boson, the initial-state radiation

produces jets that can obscure the nature of the $t\bar{t}$ decay. These jets, which are mainly gluon jets, pass all the widely used cuts that are set for top-quark detection. The events therefore look like multijet events, rather than pure two-jet events. We find that there are many pure two-jet events which consist of b or $\bar{b}$ jet plus an extra gluon jet. The effect is most prominent for top-quark mass near the W mass, 100 GeV in our case. For heavier top quark, 150 and 200 GeV, the cuts that are put on the leptons and the missing energy, which come off the top-quark decay, basically eliminate this effect. The significance of this effect will extend beyond the pure $t\bar{t}$ production channel, since it is resident in every subprocess at hadron colliders.

20682 **Searching for Z' and W' bosons of left-right-symmetric models at high-energy colliders.** Grifols, J.A. (Grup de Fisica Teorica, Universidad Autonoma de Barcelona 08193 Bellaterra (Barcelona), (Spain)); Mendez, A.; Barnett, R.M. *Physical Review [Section] D: Particles and Fields (USA),* 40(11): 3613-3615 (1 Dec 1989).

We report on the production of new gauge bosons ($W'^{\pm}$ and Z'^{0}) at the Superconducting Super Collider (SSC) and at three possible upgrades of the Fermilab Tevatron Collider. We compare the potential of the SSC to set limits and study new bosons with that of an upgraded collider, and we discuss the relative capabilities of the three Tevatron Collider upgrades.

20683 **K^0_S production in $\bar{p}p$ interactions at $\sqrt{s}$=630 and 1800 GeV.** Abe, F.; Amidei, D.; Apollinari, G.; Ascoli, G.; Atac, M.; Auchincloss, P.; Baden, A.R.; Barbaro-Galtieri, A.; Barnes, V.E.; Bedeschi, F. *Physical Review [Section] D: Particles and Fields (USA),* 40(11): 3791-3794 (1 Dec 1989).

Measurements of inclusive transverse-momentum spectra for $K_S{}^0$ mesons produced in proton-antiproton collisions at $\sqrt{s}$ of 630 and 1800 GeV are presented and compared with data taken at lower energies. The ratio, as a function of p_T, of the cross section for $K_S{}^0$ to that for charged hadrons is very similar to what is observed at lower energies. At 1800 GeV, we calculate the strangeness-suppression factor λ=0.40±0.05.

6452 Particle Interactions and Properties - Theoretical

Refer also to citation(s) 20597, 20682, 20722, 20723, 20778

20684 (BNL–43784) **Lattice quark propagator in fixed gauges.** Bernard, C. (California Univ., Santa Barbara, CA (USA). Inst. for Theoretical Physics); Murphy, D.; Soni, A.; Yee, K. Brookhaven National Lab., Upton, NY (USA). [1989]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-8909249–10: Lattice '89 international workshop, Capri (Italy), 18-21 Sep 1989). Order Number DE90006767. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A lattice study of the quenched QCD quark propagator in Landau and Coulomb gauges is reported. We find that $m_D{}^{critical}$, the value of the quark propagator pole in the chiral limit, is 290 ± 20 MeV (β = 5.7) and 350 ± 40 MeV (β = 6.0). Scaling and gauge dependence of this quantity are discussed. 7 refs., 3 figs., 3 tabs.

20685 (BNL–43793) **QCD [Quantum Chromodynamics] corrections to $p\bar{p} \rightarrow W^+ + X$: A case study.** Willenbrock, S. Brookhaven National Lab., Upton, NY (USA). Jan 1990. 41p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-8906267–5: TASI '89: Theoretical Advanced Summer Institute in elementary particle physics, Boulder, CO (USA), 4-30 Jun 1989). Order Number DE90007352. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We calculate the QCD corrections to inclusive W-boson production in proton-antiproton collisions as an example of a QCD-improved parton model calculation. 13 refs., 12 figs.

20686 (CEA-CONF–9839) **The nuclear response functions with polarized particles.** Bonin, B. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique Nucleaire a Moyenne Energie. 1989. 15p. (CONF-8903172–:). Order Number DE90752551. Available from NTIS (US Sales Only), PC A03/MF A01.

We present here a review of the problems brought up by the spin response functions in nuclei. The experimental tools involved in this study are discussed, with special emphasis on polarized hadronic probes.

20687 (CEA-CONF–9840) **What can be learned from a precise measurement of the deuteron $A(q^2)$ structure function.** Platchkov, S. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique Nucleaire a Haute Energie. 1989. 8p. (CONF-8903172–:). Order Number DE90752548. Available from NTIS (US Sales Only), PC A02/MF A01.

New accurate measurements of the deuteron $A(q^2)$ structure function for momentum transfers between 1 and 18 fm^{-2} are reported. Data are compared to several representative theoretical predictions. The neutron electric form factor is inferred from the data and its model dependence is discussed.

20688 (CONF-8902110–5) **Rare decays of the Z and the standard model, 4th generation, and beyond.** Weiler, T.J. Vanderbilt Univ., Nashville, TN (USA). Dept. of Physics and Astronomy. [1989]. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-85ER40226. From 2. international symposium on the 4th family of quarks and leptons; Santa Monica, CA (USA); 23-25 Feb 1989. Order Number DE90007182. Available from NTIS, PC A02/MF A01; OSTI; INIS.

Several issues in rare decays of the Z are addressed. The rate for flavor-changing Z decay grows as the fourth power of the fermion masses internal to the quantum loop, and so offers a window to the existence of ultraheavy ($m > M_W$) fermions. In the standard model, with three generations, $BR(Z \rightarrow bs) < 10^{-7}$ and $BR(Z \rightarrow tc) < 10^{-13}$. With four generations, $BR(Z \rightarrow bb_4)$ may be as large as 10^{-5} if $m_{b4} < M_Z$; and similarly for $BR(Z \rightarrow N_4\nu)$, where N_4 is the possibly heavy fourth generation neutrino. In supersymmetric and other two Higgs doublet models, $BR(Z \rightarrow tc)$ may be as large as 5×10^{-6} in the three generation scheme. With minimal supersymmetry, the reaction $Z \rightarrow H\gamma$ is guaranteed to go, with a parameter-dependent branching ratio of $10^{-6\pm3}$. With mirror fermions or exotic E_6 fermions, the branching ratios for $Z \rightarrow ct$ (70 GeV), $Z \rightarrow \mu\tau$, and $Z \rightarrow bb_4$ (70 GeV) are typically 10^{-4}, 10^{-4}, and 10^{-3} respectively, clearly measurable at LEP. Depending on unknown quark masses, the Z may mix with vector ($b_4\bar{b}_4$) and the W may mix with vector ($t\bar{b}$) or ($t\bar{s}$). CP violating asymmetries in flavor-changing Z decay are immeasurably small in the standard model, but may be large in supersymmetric and other nonstandard models. 28 refs.

20689 (DOE/ER/40160–6) **High energy hadron-hadron collisions: Annual progress report.** Chou, T.T. Georgia Univ., Athens, GA (USA). Dept. of Physics and Astronomy. Jan 1990. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract FG09-84ER40160. Order Number DE90007081. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Results of a study on high energy collision with the geometrical model are summarized in three parts: (i) the elastic hadron-hadron collision, (ii) the inelastic hadron-hadron collision, and (iii) the e^+e^- annihilation. The geometrical description of high-energy elastic scattering developed earlier is still in general agreement with experiments at the CERN-S$\bar{p}$pS energies. A simple one-parameter expression for the blackness of $\bar{p}p$ system has been proposed recently which describes very well all existing data from ISR to S$\bar{p}$pS energies. The geometrical description has also been extended to include processes of fragmentation and diffraction dissociation and other phenomena. In the past five years, a unified physical picture for multiparticle emission in hadron-hadron and e^+e^- collisions was developed. It focuses on the idea of the wide range of values for the total angular momentum in hadron-hadron collisions. An extension of this consideration yields a theory for the momentum distribution of the outgoing particles which agrees with $\bar{p}p$ and e^+e^- collision experiments. The results and conclusions of this theory have been extrapolated to higher energies and yielded many predictions which can be experimentally tested. 37 refs.

20690 (DOE/ER/40226–5) **Theoretical investigations in elementary particle physics: Progress report, June 1, 1989–May 31, 1990.** Weiler, T.J.; Kephart, T.W. Vanderbilt Univ., Nashville, TN (USA). Dept. of Physics and Astronomy. Jan 1990. 8p.

Sponsored by U.S. DOE Energy Research. DOE Contract FG05-85ER40226. Order Number DE90007178. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This paper is a progress report on the following topics: Isoflipped SU(5) models; Critical temperature and primordial neutrino abundancies; Production and decay of minimal SUSY Higgses at LEP and beyond; Neutrino magnetic moment in N = 1 minimal supergravity; and Theory of matter in Weyl spacetime. (LSP)

20691 (IPNO-TH–88-62) **Electromagnetic polarizabilities of pseudoscalar goldstone bosons.** Vautherin, D. (Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire); Bernard, V. Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire. Dec 1988. 24p. Order Number DE90752609. Available from NTIS (US Sales Only), PC A03/MF A01.

We calculate the electromagnetic polarizabilities of the charged and neutral pions and kaons within the framework of a generalized SU(3) Nambu and Jona-Lasinio model. We obtain strong constraints on the results from chiral symmetry. Possible effects of non-linearities in the strange current quark mass are studied. The values obtained for the charged pion electromagnetic polarizabilities are within the error bars of the experimental ones. We predict charged kaon electromagnetic polarizabilities of the order of 10^{-4} fm^3, whereas the ones of the neutral pion and kaon are an order of magnitude smaller.

20692 (IPNO-TH–89-04) **Skyrmions and effective Lagrangians.** Loiseau, B. (Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire). Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire. Jan 1989. 43p. Order Number DE90752611. Available from NTIS (US Sales Only), PC A03/MF A01.

Necessity to modelize QCD at low energy is emphasized. Outline of the $1/N_C$ expansion of QCD, for large N_C, shows the deep link between Skyrme effective Lagrangian and QCD. The Skyrme model, built from the non-linear sigma model plus a stabilizer term, related to vector dominance, is briefly described. It satisfies like QCD chiral symmetry. One illustrates how the gauged Wess-Zumino action demonstrates that the topological current can be identified with the baryon current. One recalls how one can show that topological soliton is a fermion for odd N_C. An example of an effective Lagrangian, built from pi and low mass vector meson, omega, rho and A_1 fields, is given. It describes rather well low-energy meson and baryon physics. Predictions of effective Lagrangians of Skyrme type on meson-meson, meson-baryon and baryon-baryon scatterings at low energy are depicted. A 2-phase chiral symmetric model, the chiral bag, is introduced. It contains an inner core of confined quarks and gluons surrounded by meson fields in the topological configuration of a Skyrmion. It could describe nuclei from low to high energy range.

20693 (IYaF–89-13) **High energy production of gluons in a quasi-multi-Regge kinematics.** Fadin, V.S.; Lipatov, L.N. AN SSSR, Novosibirsk (USSR). Inst. Yadernoj Fiziki. 1989. 24p. Order Number DE90616981. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Inelastic gluon-gluon scattering amplitudes in the Born approximation for the quasi-multi-Regge kinematics are calculated, starting with the Veneziano-type expression for the inelastic amplitude of the gluon-tachyon scattering with its subsequent simplification in the region of large energies and the Regge slope alpha'yields0. Results obtained allow one to determine the high order corrections to the gluon Regge trajectory, the reggeon-particle vertices and to the integral kernel of the Bethe-Salpeter equation for the vacuum t-channel partial waves. 10 refs.; 7 figs.

20694 (LAPP-TH–213-88) **Fermionizing the Z^2-orbifold.** McCabe, J. Grenoble-1 Univ., 74 - Annecy (France). Lab. de Physique des Particules Elementaires. Mar 1988. 13p. Order Number DE90752601. Available from NTIS (US Sales Only), PC A03/MF A01.

We demonstrate the equivalence of free 2d bosons, taking values on a symmetric Z^2-orbifold, to various fermionic theories. The fermions satisfy boundary conditions like Psi(-pi,t) = Psi*(pi,t) and can be free or interact through Thirring couplings.

20695 (LAPP-TH–214-88) **Fermionic construction of vertex operators for twisted affine algebras.** Frappat, L. (Grenoble-1 Univ., 74 - Annecy (France). Lab. de Physique des Particules); Sorba, P.; Frappat, L.; Sciarrino, A. Grenoble-1 Univ., 74 - Annecy (France). Lab. de Physique des Particules Elementaires. Mar 1988. 35p. Order Number DE90752602. Available from NTIS (US Sales Only), PC A03/MF A01.

We construct vertex operator representations of the twisted affine algebras in terms of fermionic (or parafermionic in some cases) elementary fields. The folding method applied to the extended Dynkin diagrams of the affine algebras allows us to determine explicitly these fermionic fields as vertex operators.

20696 (LAPP-TH–226-88) **Radiative corrections to Drell-Yan production in a quark-gluon plasma.** Altherr, T. Grenoble-1 Univ., 74 - Annecy (France). Lab. de Physique des Particules Elementaires. Jul 1988. 6p. (CONF-8806260–: 19. international symposium on multiparticle dynamics - new data and theoretical trends, Arles (France), 13-17 Jun 1988). Order Number DE90752604. Available from NTIS (US Sales Only), PC A02/MF A01.

First order QCD corrections to the production of lepton pairs in a quark-gluon plasma at finite temperature are presented, within the real-time formalism. We show that both infrared and mass singularities cancel in the final result.

20697 (LA-UR–90-158) **Symmetry violations and rare decays.** Coleman, R. (Fermi National Accelerator Lab., Batavia, IL (USA)); Bock, G.; Enagonio, J.; Hsiung, B.; Yamanaka, T.; Winstein, B.; Wah, Y.; Yamamoto, H.; Cooper, M.; Ewin, A. Los Alamos National Lab., NM (USA). [1989]. 40p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-890872–5: Workshop on physics at Fermilab in the 1990's, Breckenridge, CO (USA), 15-24 Aug 1989). Order Number DE90006515. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This constitutes the report of the working group on symmetry violations and rare decays. The next generation of CP violating kaon decay experiments (the 2π and $\pi^0e^+e^-$ modes) were considered at the Tevatron and at the proposed Main Injector, effectively building upon the work of the earlier Fermilab Workshop on Physics at the Main Injector. The optimizations for the electromagnetic calorimeter and for background rejection are treated in some detail. Very precise CPT tests in the 2π decay modes are also treated. A sensitive experiment looking for flavor violation at the Main Injector ($K_L \rightarrow \mu e$) is discussed. The significant advantages of possible stretcher and prebooster rings are mentioned. 27 refs., 5 figs., 3 tabs.

20698 (RAL–89-042) **QED at fifth order in e^+e^- annihilation.** Brown, N. Rutherford Appleton Lab., Chilton (UK). May 1989. 19p. Order Number DE90616952. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We calculate the cross-section for the production of e^+e^-gammagammagamma in e^+e^- annihilation. The results are in agreement with the first observation of such a process by the ASP experiment at SLAC. The calculation also provides another example of the power of 'spinor techniques' in calculating Feynman amplitudes. (author).

20699 (SINS–2063/P-6/PH/A) **Diquarks in elementary particle physics.** Szczekowski, M. Institute for Nuclear Studies, Otwock-Swierk (Poland). Oct 1988. 114p. Order Number DE90616982. Available from NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS.

Many phenomena in elementary particle physics show indications of clustering of two quarks inside baryons. Although the existence of such diquark systems cannot be presently rigourously proven in quantum field theory of strong interactions, phenomenological models require some quark-quark binding to explain effects ranging from the baryon mass spectrum to large p_T proton production in high energy pp collisions. This review confronts diquark models predictions with experimental results in low and high transverse momentum hadron-hadron collisions, lepton-nucleon scattering and e^+e^- annihilations. The recent data from the Split Field Magnet detector on high p_T proton production in pp, dd and alphaalpha collisions at ISR energies are particularly emphasized. 83 refs., 59 figs. (author).

20700 Analytical progress towards the mass spectrum and deconfining temperature in SU(3) gauge theory. Vohwinkel, C. (Department of Physics and Supercomputer Computations Research Institute, Florida State University, Tallahassee, Florida 32306 (US)). *Physical Review Letters (USA)*, 63(23): 2544-2547 (4 Dec 1989).

Using Luescher's small-volume expansion, mass spectrum and deconfining temperature of SU(3) gauge theory are evaluated. Including nonperturbative features by restoring symmetries which were broken in perturbation theory we obtain results which are valid up to intermediate volumes. The mass spectrum obtained is in good agreement with the perturbative results for small volumes, and with Monte Carlo data in medium-sized volumes. Using asymmetric volumes we are able to estimate the deconfining temperature and find reasonable agreement with Monte Carlo calculations.

20701 Partial-wave analysis of the $pp\to p n\pi^+$ reaction. Lee, T.H. (Physics Division, Argonne National Laboratory, Argonne, Illinois 60439 (US)). *Physical Review [Section] C: Nuclear Physics (USA)*, 40(6): 2911-2913 (Dec 1989). DOE Contract W-31-109-ENG-38.

We establish the relationship between the partial-wave analysis of the $pp\to p n\pi^+$ reaction by Shypit *et al.* [Phys. Rev. Lett. 60, 901 (1988); 61, 2385 (1988)] and the unitary formulation of the πNN problem. It is shown that the $N\Delta$ phases extracted by Shypit *et al.* are not exclusively due to the $N\Delta$ interaction.

20702 Multiphoton Monte Carlo event generator for Bhabha scattering at small angles. Jadach, S. (Institute of Physics, Jagellonian University, Cracow, Poland (PL)— CERN, CH-1211, Geneva 23, (Switzerland)— SLAC, P.O. Box 4349, Stanford, California 94309 (USA)); Ward, B.F.L. *Physical Review [Section] D: Particles and Fields (USA)*, 40(11): 3582-3589 (1 Dec 1989).

We describe in this paper the application of the theory of Yennie, Frautschi, and Suura (YFS) to construct a Monte Carlo (MC) event generator with multiple-photon production for Bhabha scattering at low angles. The respective generator provides the four-momenta of the electron and positron and of all soft and hard photons with a proper treatment of the phase space and conservation of the total four-momentum. The final-state electron and positron are assumed to be visible above some minimum angle with respect to the beams (double tag). The QED matrix element in the algorithm is taken according to the YFS exponentiation scheme. The Monte Carlo program will be helpful in luminosity determination at experiments at the SLAC Linear Collider and the CERN collider LEP; it takes into account QED $O(\alpha)$ and the leading higher-order corrections. The important difference with the existing MC procedures is that the minimum energy above which photons are generated may be set arbitrarily low. Sample Monte Carlo data are illustrated in our discussion.

20703 Spin and parity analyses in radiative quarkonium decays: Three-particle final states. Banerjee, S. (Department of Physics and Institute of Nuclear and Particle Physics, University of Virginia, Charlottesville, Virginia 22901 (US)). *Physical Review [Section] D: Particles and Fields (USA)*, 40(11): 3641-3647 (1 Dec 1989).

Angular distributions of radiative quarkonium cascade decays into three particles are presented, using the helicity formalism. These three particles can be either three pseudoscalar mesons or a lepton-antilepton pair and a pseudoscalar meson. Three-meson final states also occur in two-body sequential decays when the intermediate state χ formed in the radiative decay of quarkonium subsequently decays into a meson resonance decaying into a meson pair, along with a third meson. Inferences on the spins and parities of the intermediate χ are made.

20704 Lower bounds on the constituent-quark mass differences. Lichtenberg, D.B. (Physics Department, Indiana University, Bloomington, Indiana 47405 (US)). *Physical Review [Section] D: Particles and Fields (USA)*, 40(11): 3675-3678 (1 Dec 1989).

Using a potential-model approximation to quantum chromodynamics and the masses of ground-state mesons and baryons as input, we obtain lower bounds on the constituent-quark mass differences. We find $m_d-m_u>4.1\pm0.3$ MeV, $m_s-\bar{m}>184\pm4$ MeV, $m_c-m_s>1180\pm4$ MeV, and $m_b-m_c>3343\pm4$ MeV, where $\bar{m}$ is the average mass of the u and d quarks.

20705 $1/N_c$ corrections to π-nucleon scattering relations in chiral soliton models. Amado, R.D. (Department of Physics, University of Pennsylvania, Philadelphia, Pennsylvania 19104 (USA)); Oka, M.; Mattis, M.P. *Physical Review [Section] D: Particles and Fields (USA)*, 40(11): 3622-3626 (1 Dec 1989).

We study the leading algebraic finite-N_c (number of colors) corrections to the π-nucleon scattering relations of Mattis, Peskin, and Karliner. We find that these corrections do not spoil the qualitative success of their relations in the high partial waves but that further dynamical finite-N_c corrections are needed to correct the inadequacy of the relations in the S and P waves.

20706 Identification of θ [$f_2(1720)$] as a tensor glueball. Liu, K.F. (Department of Physics and Astronomy, University of Kentucky, Lexington, Kentucky 40506 (USA)); Li, B.A.; Ishikawa, K. *Physical Review [Section] D: Particles and Fields (USA)*, 40(11): 3648-3654 (1 Dec 1989).

By incorporating a soft form factor, we show that $\theta[f_2(1720)]$ has flavor-independent decays to $K\bar{K}$, $\eta\eta$, and $\pi\pi$. The same form factor is needed to understand the suppression of θ in $K^-p\to\Lambda K_S{}^0K_S{}^0$ as well as its emergence in the central productions of $\pi p\to\pi(K^+K^-)p$ and $pp\to p(K^+K^-)p$. This flavor-symmetric feature of θ is further enhanced by comparing $f_2{}'(1525)$ and θ in J/ψ decays to $\gamma K\bar{K}$, $\omega K\bar{K}$, and $\phi K\bar{K}$. The absence of θ in $\gamma\gamma\to K_S{}^0K_S{}^0$ and $K^-p\to\Lambda K_S{}^0K_S{}^0$ leads us to conclude that the quark content in θ is very low. With θ shown to be a flavor singlet and void of quarks, we believe that θ could indeed be a tensor glueball, subject to the verification of the soft form factor.

20707 Breaking of SU(3) in vector-meson radiative decays. Bramon, A. (Grup de Fisica Teorica, Universitaet Autonoma de Barcelona, 08193 Bellaterra, Barcelona, Spain (ES)); Scadron, M.D. *Physical Review [Section] D: Particles and Fields (USA)*, 40(11): 3779-3781 (1 Dec 1989).

The radiative decays of charged and neutral K^* vector mesons are discussed in a general quark-model context. Their ratio is found to be particularly appropriate for the analysis of SU(3) breaking in terms of the ratio $\bar{M}/M$ of strange-to-nonstrange (constituent) quark masses. The standard value $\bar{M}/M\simeq1.5$ is clearly favored. Other $V\to P\gamma$ decays are discussed.

20708 Hadronization from supercooled baryon-rich quark-gluon plasma. Holme, A.K. (Department of Physics, University of Bergen, Allegaten 55, N-5007 Bergen, (Norway)); Staubo, E.F.; Csernai, L.P.; Osnes, E.; Strottman, D. *Physical Review [Section] D: Particles and Fields (USA)*, 40(11): 3735-3742 (1 Dec 1989).

A simple phenomenological model for the nuclear equation of state is introduced and the dependence of the phase boundaries on the parameters is discussed. The equations for relativistic shocks are then applied to study the compression of hadronic matter and the hadronization of supercooled baryon-rich plasma. The results show little sensitivity to the different parametrizations of the hadronic equation of state. However, they may be sensitive to dynamic properties such as the hadronization rate.

20709 Pion-pair contribution to the decay $K_L\to\pi^0\gamma\gamma$. Ko, P. (Enrico Fermi Institute—Department of Physics, University of Chicago, Chicago, Illinois 60637 (USA)); Rosner, J.L. *Physical Review [Section] D: Particles and Fields (USA)*, 40(11): 3775-3778 (1 Dec 1989).

A simple prediction for the decay $K_L\to\pi^0\gamma\gamma$, obtained from the rescattering to two photons of the $\pi^+\pi^-$ intermediate state in the process $K_L\to\pi^+\pi^-\pi^0$, is compared with a recent calculation based on chiral perturbation theory. The $\pi^+\pi^-$ rescattering model predicts a two-photon effective mass spectrum peaked at slightly higher $m_{\gamma\gamma}$ than in chiral perturbation theory, and a branching ratio $B(K_L\to\pi^0\gamma\gamma)\approx7.5\times10^{-7}$. Implications are discussed for the corresponding decay of the charged kaon.

6453 Particle Invariance Principles and Symmetries

Refer also to citation(s) 20691, 20697, 20707

20710 (UM-P–89/03) **Gauged baryon and lepton numbers.** Foot, R.; Joshi, G.C.; Lew, H. Melbourne Univ., Parkville (Australia). School of Physics. [1989]. 11p. (OZ–89/2). Order Number DE90616674. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A possible extension of the Standard Model can be defined by gauging the global baryon and lepton number U(1) symmetries. Gauging baryon and lepton numbers provide a natural framework for the see-saw mechanism in the lepton sector, and the Peccei-Quinn mechanism in the quark sector. Another consequence of this extension is that the usual three generations of fermions are not anomaly free. However the authors consider a wider framework involving the existence of generations with exotic $SU(2)_L$ tensor product $U(1)_Y$ quantum numbers. This allows them to derive a minimal spectrum of fermions which contain the known quarks and leptons. 12 refs.

20711 (WIS-PH–88/12) **Modular invariance, chiral anomalies and contact terms.** Kutasov, D. Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Physics. Mar 1988. 40p. Order Number DE90616675. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The chiral anomaly in heterotic strings with full and partial modular invariance in D=2n+2 dimensions is calculated. The boundary terms which were present in previous calculations are shown to be cancelled in the modular invariant case by contact terms, which can be obtained by an appropriate analytic continuation. The relation to the low energy field theory is explained. In theories with partial modular invariance, an expression for the anomaly is obtained and shown to be non zero in general. (author). 17 refs.

20712 Left-right symmetry with baryon- and lepton-number conservation as gauge symmetries. Rajpoot, S. (Department of Physics, University of California, Riverside, California 92521 (US)). *Physical Review [Section] D: Particles and Fields (USA),* 40(11): 3795-3798 (1 Dec 1989).

An $SU(2)_L \times SU(2)_R \times U(1)_B \times U(1)_I$ model is described in which Abelian gauge symmetries are associated with the observed conservation in nature of baryon and lepton numbers. The triangle anomalies of the three families of quarks and leptons in the model are canceled by invoking leptoquark matter which is new fermionic matter that carries baryon as well as lepton numbers. In addition to the standard neutral boson (Z^0), the theory predicts two massive neutral gauge bosons. The lower bounds on their masses are in the few hundred GeV mass range which makes these particles prospective candidates for production at CERN LEP, the Fermilab Tevatron, and the Superconducting Super Collider.

20713 Futility of high-precision SO(10) calculations. Dixit, V.V. (High Energy Physics Division, Argonne National Laboratory, Argonne, Illinois 60439 (USA)— Department of Science and Mathematics, Parks College of St. Louis University, Cahokia, Illinois 62206 (USA)); Sher, M. *Physical Review [Section] D: Particles and Fields (USA),* 40(11): 3765-3769 (1 Dec 1989). DOE Contract W-31-109-ENG-38.

In grand unified models, there are a large number of scalar bosons with masses of the order of the unification scale. Since the masses could be an order of magnitude or so above or below the vector-boson masses, they will affect the beta functions and thus low-energy predictions; the lack of knowledge of the masses translates into an uncertainty in these predictions. Although the effect is very small for a single scalar field, SO(10) models have hundreds of such fields, leading to very large uncertainties. We analyze this effect in SO(10) models with intermediate scales, and show that all such models have an *additional* uncertainty which can be as large as 4 orders of magnitude in the proton lifetime and as large as a factor of 0.02 in $\sin^2\theta_w$. In models with 210-dimensional representations, the weak mixing angle is uncertain by as much as 0.06. As a result, we argue that precise calculations in SO(10) models with intermediate scales may not be possible.

6454 Field Theory

Refer also to citation(s) 20679, 20680, 20684, 20692, 20704, 20708, 20713, 20773

20714 (BiBoS–376/89) **Construction of quantised Higgs-like fields in two dimensions.** Albeverio, S. (Bochum Univ. (Germany, F.R.)); Hoeegh-Krohn, R.; Holden, H.; Kolsrud, T. Bielefeld Univ. (Germany, F.R.). Forschungszentrum Bielefeld-Bochum-Stochastik (BiBoS); Bochum Univ. (Germany, F.R.). Sonderforschungsbereich 237 - Unordnung und Grosse Fluktuationen. 1989. 11p. Order Number DE90753691. Available from NTIS (US Sales Only), PC A03/MF A01.

A mathematical construction of Higgs-like fields in two dimensions is presented, including passage to the continuum and infinite volume limits. In the limit, a quantum field theory obeying the Osterwalder-Schrader axioms is obtained. The method is based on representing the Schwinger functions in terms of stochastic multiplicative curve integrals and brownian bridges. (orig.).

20715 (CEA-CONF–9802) **Conformal field theories, Coulomb gas picture and integrable models.** Zuber, J.B. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique Theorique. 1988. 32p. (CONF-8806456–: Meeting on fields, strings and critical phenomena, Les Houches (France), 28 Jun - 5 aug 1988). Order Number DE90752606. Available from NTIS (US Sales Only), PC A03/MF A01.

The aim of the study is to present the links between some results of conformal field theory, the conventional Coulomb gas picture in statistical mechanics and the approach of integrable models. It is shown that families of conformal theories, related by the coset construction to the SU(2) Kac-Moody algebra, may be regarded as obtained from some free field, and modified by the coupling of its winding numbers to floating charges. This representation reflects the procedure of restriction of the corresponding integrable lattice models. The work may be generalized to models based on the coset construction with higher rank algebras. The corresponding integrable models are identified. In the conformal field description, generalized parafermions appear, and are coupled to free fields living on a higher-dimensional torus. The analysis is not as exhaustive as in the SU(2) case: all the various restrictions have not been identified, nor the modular invariants completely classified.

20716 (IPNO-TH–88-71) **Some obstructions in quantum field theory.** Sergent, P. Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire. Dec 1988. 5p. (In French). Order Number DE90752608. Available from NTIS (US Sales Only), PC A02/MF A01.

We remind that for a quantized field with positive energy: there is no spin 1/2 irreducible real field (no Majorana field, no two component neutrino field); there is no spin 1,m>0 field. Moreover there is no supersymmetry generators (contrary to many assertions).

20717 (IPNO-TH–89-1) **Variational extension of the time-dependent mean field approach.** Flocard, H. Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire. 1989. 23p. Order Number DE90752610. Available from NTIS (US Sales Only), PC A03/MF A01.

We investigate an application of the variational principle of Balian and Veneroni for density operators and observables. Our choice for the trial spaces incorporates correlations in the density operator. It allows one to calculate the expectation values of both one-body and two-body observables. We derive a set of coupled equations which extends the TDHF formalism, and determines the evolution of the partition function, the one-body density and the second cumulant (it corresponds also to a truncation of the quantal counterpart of the BBKGY equations). By restricting further the trial space for the two-body observables, the variational principle generates simpler equations which still include the effects of a selected class of correlations on the evolution of the one-body density.

20718 (LAPP-TH–208-88) **Differential algebras in field theory.** Stora, R. (Grenoble-1 Univ., 74 - Annecy (France). Lab. de Physique des Particules (France)). Grenoble-1 Univ., 74 - Annecy (France). Lab. de Physique des Particules Elementaires. 1988. 18p. (CONF-8712159–: 2. summer meeting on quantum mechanics of fundamental systems, Santiago (Chile), 17-20 Dec 1987). Order Number DE90752605. Available from NTIS (US Sales Only), PC A03/MF A01.

The applications of differential algebras, as mathematical tools, in field theory are reviewed. The Yang-Mills theories are recalled

and the free bosonic string model is treated. Moreover, in the scope of the work, the following topics are discussed: the Faddeev Popov fixed action, in a Feynman like gauge; the structure of local anomalies, including the algebric and the topological theories; the problem of quantizing a degenerate state; and the zero mode problem, in the treatment of the bosonic string conformal gauge. The analysis leads to the conclusion that not much is known about situations where a non involutive distribution is involved.

20719 (LAPP-TH-222-88) **Vertex operators for affine algebras and superalgebras.** Frappat, L. (Naples Univ. (IT). Dipt. di Scienze Fisiche); Sorba, P.; Sciarrino, A. Grenoble-1 Univ., 74 - Annecy (France). Lab. de Physique des Particules Elementaires. May 1988. 13p. (CONF-8803253--: 3. annecy meeting in theoretical physics on conformal field theory and related topics, Annecy (France), 14-16 Mar 1988). Order Number DE90752600. Available from NTIS (US Sales Only), PC A03/MF A01.

We emphasize the role of the boson-fermion correspondence in two dimensional conformal field theory for the realization of level one representations of affine untwisted and twisted Kac-Moody algebras via vertex operators. Using also the boson-boson correspondence, vertex operators for contragredient affine superalgebras can be constructed.

20720 (LA-UR-90-3) **Construction of four-dimensional open superstrings.** Bern, Z. (Los Alamos National Lab., NM (USA)); Dunbar, D.C. Los Alamos National Lab., NM (USA). [1989]. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-8911164--1: 1989 superstrings workshop, Tuscaloosa, AL (USA), 8-11 Nov 1989). Order Number DE90006484. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

We present the first examples of space-time supersymmetric one-loop finite four-dimensional open superstrings. 21 refs., 1 fig.

20721 **Dynamical mass generation in 3D four-fermion theory.** Semenoff, G.W. (Department of Physics, University of British Columbia, Vancouver, British Columbia (Canada)— Department of Physics, University of Cincinnati, Cincinnati, OH (USA)); Wijewardhana, L.C.R. *Physical Review Letters (USA),* 63(24): 2633-2636 (11 Dec 1989).

A mechanism for dynamical generation of fermion mass in three dimensions is proposed. Spontaneous breaking of parity as well as certain flavor symmetry is discussed.

20722 **Effect of fourth-generation quarks on $b \to s\gamma$.** Deshpande, N.G. (University of Oregon, Eugene, Oregon 97403 (US)); Trampetic, J. *Physical Review [Section] D: Particles and Fields (USA),* 40(11): 3773-3774 (1 Dec 1989).

The effect of a fourth generation of quarks on $b \to s\gamma$ including QCD corrections is evaluated and found to be significant.

20723 **Heavy-light scalar-quark system in the leading-log effective-action model: Exact solution.** Mendel, R.R. (Department of Applied Mathematics, The University of Western Ontario, London, Ontario, Canada N6A 5B9 (Canada)); Trottier, H.D. *Physical Review [Section] D: Particles and Fields (USA),* 40(11): 3708-3721 (1 Dec 1989).

An exact solution is obtained in a renormalization-group-improved effective-action model of QCD, for a system containing an infinitely heavy antiquark and a scalar quark of arbitrary mass. The solution corresponds to a solitonlike S-wave state of finite radius R. The only input parameters are the QCD scale $\Lambda_{\overline{MS}}$ (where $\overline{MS}$ denotes the modified minimal subtraction scheme), the number of light quark flavors N_f, and the scalar-quark mass m. Color confinement arises from the nonlinear properties of the effective action. An analysis of the radial excitations (m=0) of the S-wave soliton state clearly shows that this confinement is linear. We find for high radial excitations that the leading behavior of the total energy of the system (m=0) is $U_N = Q\kappa R_N + const$, where $Q=\sqrt{4/3}$, $\kappa^{1/2}=1.043\Lambda_{\overline{MS}}$ (N_f=3), and R_N is the radius of the soliton corresponding to the Nth radial excitation. A detailed description is given of the properties of the ground-state soliton as a function of N_f and m. An analytical expression is obtained for the short-distance behavior of the scalar-quark wave function.

65 PHYSICS II

Refer also to citation(s) 19704, 20658

20724 (ORNL-6582) **Engineering Physics and Mathematics Division progress report for period ending August 31, 1989.** Oak Ridge National Lab., TN (USA). Dec 1989. 302p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90006440. Available from NTIS, PC A15/MF A01; OSTI; INIS; GPO Dep.

This paper contains abstracts on research performed at the Engineering Physics and Mathematics Division of Oak Ridge National Laboratory. The areas covered are: mathematical science; nuclear-data measurement and evaluation; intelligent systems; nuclear analysis and shielding; and Engineering Physics Information Center. (LSP)

6510 Nuclear Physics

Refer also to citation(s) 20660, 20974

20725 (CONF-8903175--3) **Transverse energy scaling and energy density estimates from ^{16}O- and ^{32}S-induced reactions.** WA80 Collaboration. Oak Ridge National Lab., TN (USA). [1989]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-87ER40361;AC05-84OR21400. From Recontre de Moriond conference; Les Arcs (France); 12-17 Mar 1989. Order Number DE90007334. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

We discuss the dependence of transverse energy production on projectile mass, target mass, and on the impact parameter of the heavy ion reaction. The transverse energy is shown to scale with the number of participating nucleons. Various methods to estimate the attained energy density from the observed transverse energy are discussed. It is shown that the systematics of the energy density estimates suggest averages of 2–3 GeV/fm^3 rather than the much higher values attained by assuming Landau-stopping initial conditions. Based on the observed scaling of the transverse energy, an initial energy density profile may be estimated. 14 refs., 4 figs.

20726 (CONF-8908148--5) **Fluctuations in transverse energy and multiplicity, energy densities, and neutral pion spectra in nucleus-nucleus collisions at 200 GeV/nucleon.** WA80 Collaboration. Oak Ridge National Lab., TN (USA). [1989]. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-87ER40361;AC05-84OR21400. From International workshop on relativistic aspects of nuclear physics; Rio de Janeiro (Brazil); 28-31 Aug 1989. Order Number DE90007337. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The main goal of the CERN heavy-ion experiments is the search for an indication that the predicted state of deconfined quarks and gluons, the quark-gluon plasma (QGP), has been produced. The quantity most crucial to the probability of QGP formation is the thermalized energy density attained during the heavy-ion reaction. The amount of energy radiated transverse to the beam direction is the experimental quantity which is believed to be a measure of the amount of energy deposition in the reaction, and hence to reflect the energy density attained. In this presentation we consider the systematics of transverse energy production at CERN SPS energies, and we use the results to make estimates, under various assumptions, of attained energy densities.

20727 (DOE/ER/40342--3) **Colorado School of Mines Low Energy Nuclear Physics Project technical progress report.** Cecil, F.E. Colorado School of Mines, Golden, CO (USA). 5 Jan 1990. 53p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-87ER40342. Order Number DE90007550. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

This report summarizes the activity and accomplishments of the Colorado School of Mines Low Energy Nuclear Physics project during the calendar year 1989. Many of the projects which were anticipated in the original grant proposal have been completed. Among these completed projects we include of study of the radiative capture of low energy protons on ^{6}Li, ^{7}Li, ^{9}Be, and ^{11}B. Preliminary measurements of the branching ratios and yields of

these reactions were reported in last year's Technical Progress Report. These measurements are now complete and have been used to extract the respective astrophysical S-factors and the corresponding thermonuclear reactivities. While not complete, progress has been made in some of the other originally proposed studies. Among these include a fairly extensive study of the interaction of low energy deuterons with ^{6}Li and ^{7}Li. In the course of this study we have made a solid observation of the Oppenheimer-Phillips effect in the D-^{6}Li system. Progress has been made in our study of the radiative capture of alpha particles by deuterons, ^{6}Li, and ^{7}Li but considerable work remains in these studies. In our earlier reports we noted the observation of d-d reactions during the bombardment of deuterated targets with energetic beams of protons, alpha particles, and other light-to-medium ions. We believe we now understand this phenomenon and feel it has some fairly significant consequences both for our studies and for those of other researchers. Our susceptibility to mob hysteria led us to invest a significant effort in cold nuclear fusion, both employing a fairly unique accelerator based approach at CSM and as one of the gamma ray diagnosticians on the Princeton Plasma Physics Laboratory's Cold Fusion Task Force.

20728 (INDC(NDS)–230/L) **Measurements and analysis of double differential neutron spectra in (p,n) and (alpha,n) reactions: Summary report. 3. research co-ordination meeting, Bologna, Italy, 13-15 November 1989.** Kocherov, N.P. International Atomic Energy Agency, Vienna (Austria). International Nuclear Data Committee. Dec 1989. 10p. (CONF-8911169–: 3. research co-ordination meeting on measurements and analysis of double differential neutron spectra in (p,n) and (alpha,n) reactions, Bologna (Italy), 13-15 Nov 1989). Order Number DE90617141. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The document presents the conclusions and the recommendations of the third Research Co-ordination Meeting on measurements and analysis of double differential neutron spectra in (p,n) and (alpha,n) reactions.

20729 (LA-UR–90-493) **Searching for existing nuclear data.** Tesmer, J.R. (Los Alamos National Lab., NM (USA)); Cokal, H.; Maggiore, C.J. Los Alamos National Lab., NM (USA). [1989]. 5p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-8906186–7: Materials Research Society materials analysis workshop, Albuquerque, NM (USA), 14-17 Jun 1989). Order Number DE90007535. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

As an example of finding existing data useful for high energy and heavy ion materials analysis the Nuclear Structure References of Brookhaven National Laboratory's National Nuclear Data Center was searched. The search was limited to incident ions of mass $\leq$ 7 amu (excluding alphas) with energies under 100 MeV, and the target nuclei were limited to mass $\leq$ 30 amu. Ease of use, time necessary for retrieval as well as pertinence was explored. Examples of applicable data found during the search are presented. 8 refs., 1 tab.

6512 Nuclear Properties and Reactions, A = 1-5, Experimental

20730 (DOE/ER/40451–2) **Measurement of observables in the pion-nucleon system and investigation of charge symmetry in ^{3}H and ^{3}He: Progress report, February 1, 1989–February 1, 1990.** Sadler, M.E.; Isenhower, L.D. Abilene Christian Univ., TX (USA). 1 Feb 1990. 47p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-88ER40451. Order Number DE90007421. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The LAMPF experiments have been performed in collaboration with UCLA, George Washington University, various groups at Los Alamos, and Catholic University. This paper discusses: a complete set of observables in the pion-nucleon system in the momentum interval 400-700 MeV/c; differential cross sections at low energy for pion-nucleon charge exchange; and elastic and inelastic scattering of $\pi^{\pm}$ on ^{3}H and ^{3}He.

20731 **Inclusive and exclusive quasielastic $\vec{p}$+^{2}H spin observables at 647 and 800 MeV.** Barlett, M.L. (Department of Physics, The University of Texas at Austin, Austin, Texas 78712 (USA)); Hoffmann, G.W.; Ray, L.; Pauletta, G.; McNaughton, K.H.; Amann, J.F.; Jones, K.W.; McClelland, J.B.; McNaughton, M.W.; Fergerson, R. *Physical Review [Section] C: Nuclear Physics (USA)*, 40(6): 2697-2709 (Dec 1989).

Inclusive quasielastic $\vec{p}$+^{2}H analyzing-power and spin-rotation depolarization (D_{ij}) data are reported for the nucleon-nucleon center-of-momentum angular ranges 46.9°–118.0° and 58.3°–110.0° at 647 and 800 MeV, respectively. Exclusive quasielastic $\vec{p}\,p$ and $\vec{p}\,n$ analyzing-power data and exclusive $\vec{p}\,p\,D_{ij}$ data are also presented. A simple isospin weighting model successfully describes the inclusive data and is used to estimate the free $\vec{p}\,n\,D_{ij}$ values. The new data are compared with those of previous experiments and with predictions of phase-shift analyses. The deduced $\vec{p}\,n\,D_{ij}$ values extend the angular range of previous 800 MeV data and provide entirely new information at 647 MeV.

6513 Nuclear Properties and Reactions, A = 6-19, Experimental

20732 **Search for particle-bound neutral nuclei in heavy-ion-induced reactions.** Kozub, R.L. (Department of Physics, Tennessee Technological University, Cookeville, Tennessee 38505 (US)); Prahovic, M.G. *Physical Review [Section] C: Nuclear Physics (USA)*, 40(6): 2581-2584 (Dec 1989).

An experimental test for the production of bound multineutron systems in the low center-of-mass energy environment of kinematically reversed heavy-ion reactions is described. The cross section for ^{A}n production, where $A \leq 5$, is estimated to be <2 μb, integrated over angles, energies, and A.

6514 Nuclear Properties and Reactions, A = 20-38, Experimental

Refer also to citation(s) 20993

20733 (GANIL-P–89-10) **No limit to fusion in nucleus-nucleus central collisions. Study of ^{40}Ar on ^{27}Al from 25 to 85 MeV/u.** Hagel, K. (Grand Accelerateur National d'Ions Lourds (GANIL), 14 - Caen (France)); Peghaire, A.; Jin, G.M.; Cussol, D.; Doubre, H.; Peter, J.; Saint-Laurent, F.; Motobayashi, T.; Bizard, G.; Brou, R. Grand Accelerateur National d'Ions Lourds (GANIL), 14 - Caen (France). 1989. 14p. Order Number DE90752559. Available from NTIS (US Sales Only), PC A03/MF A01.

Light charged particles and fragments emitted in collisions between ^{40}Ar projectiles (from 25 to 85 MeV/u) and ^{27}Al target nuclei have been detected in a 2Pi geometry, i.e. nearly 4Pi in the center-of-mass frame. An event-by-event analysis based on the use of the momentum sphericity tensor allowed to identify part of the central collision events. The angular distribution of light charged particles and fragments show that an incomplete fusion nucleus is formed and decays via isotropic emission at all incident energies, although no heavy residue is left above 36 MeV/u. Fusion is less and less complete as the incident energy increases. Nevertheless, a steady increase in the multiplicity of charged particles shows that the average excitation energy increases.

20734 (UCRL–102293) **Measurement of cross sections: New needs and possibilities.** Boyd, R.N. (Ohio State Univ., Columbus, OH (USA)). Lawrence Livermore National Lab., CA (USA). 1 Nov 1989. 16p. Sponsored by U.S. DOE Defense Programs; National Science Foundation. DOE Contract W-7405-ENG-48. Contract PHY86-00749. (CONF-8910320–3: Workshop on primordial nucleosynthesis, Chapel Hill, NC (USA), 6-8 Oct 1989). Order Number DE90007248. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Experimental studies of nuclear cross sections over the past several decades have done much to elucidate the processes of nucleosynthesis and energy generation in a variety of astrophysical sites. Recent studies have begun to focus on reactions which have

not previously been studied either because they were experimentally difficult, or because they had been overlooked as being important a proposed study of the $^{26}Al^{m}(p,\gamma)^{27}Si$ reaction as an example of an experiment which will soon be feasible. It will then present results of some new theoretical work on primordial nucleosynthesis which pinpoints some of the critical reactions for which no cross section measurements have been made. These primarily involve ^{8}Li, a key nucleus in one model of primordial nucleosynthesis. Finally, instrumentation needed for future measurements in nuclear astrophysics will be discussed. 31 refs., 5 figs.

20735 **Fusion-evaporation cross sections for $^{24}Mg+^{24}Mg$ at $5<E_{lab}<9$ MeV/nucleon.** Prosser, F.W. (University of Kansas, Lawrence, Kansas 66045 (USA)); Reinert, S.V.; Kovar, D.G.; Rosner, G.; Stephans, G.S.F.; Kolata, J.J.; Maguire, C.F.; Szanto de Toledo, A.; Szanto, E. *Physical Review [Section] C: Nuclear Physics (USA)*, 40(6): 2600-2610 (Dec 1989). DOE Contract AC02-79ER10420.

The evaporation residue cross sections for the fusion of the $^{24}Mg+^{24}Mg$ system have been obtained at laboratory energies of 111, 160, and 206 MeV. Angular distributions of the evaporation residues were measured and used to determine the cross sections. These cross sections decrease at the higher energies, characteristic of a limiting angular momentum. Results are compared with the predictions of fusion-evaporation models and to the systematics known from other light heavy-ion systems. Evidence is presented for a contribution from incomplete fusion and for a possible contribution from the evaporation of ejectiles heavier than α particles to the fusion-evaporation cross section at 206 MeV.

20736 **Pion charge exchange to the isovector giant dipole state at energies above the 3-3 resonance.** Loveman, R.A. (Nuclear Physics Laboratory, University of Colorado, Boulder, Colorado 80309 (US)); Clausen, B.L.; Peterson, R.J.; Rokni, S.H.; Baer, H.W.; Bergmann, A.G.; Bowman, J.D.; Irom, F.; Seftor, C.J.; Alster, J. *Physical Review [Section] C: Nuclear Physics (USA)*, 40(6): 2710-2716 (Dec 1989).

Small-angle differential cross sections for the (π^{+},π^{0}) reaction have been measured at energies of 300, 425, and 500 MeV for the isovector giant dipole resonance in a range of targets. Peak differential cross sections are inferred by extrapolation in angle. The target-mass dependence of these cross sections, normalized to the expected sum rule, shows the same mass dependence at 425 MeV that is observed for isobaric analog state transitions.

6515 Nuclear Properties and Reactions, A = 39-58, Experimental

Refer also to citation(s) 20993

20737 (INDC(CPR)–15/L) **Evaluation of neutron nuclear data of natural calcium for CENDL-1.** Tang Gouyou (Beijing Univ., BJ (China). Inst. of Heavy Ion Physics); Bao Shanglian; Shi Zhaomin; Cao Wentian. International Atomic Energy Agency, Vienna (Austria). International Nuclear Data Committee. Mar 1989. 18p. Order Number DE90617152. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Neutron nuclear data of natural calcium for CENDL-1 has been evaluated in the energy region from 10^{-5} ev to 20 MeV. Evaluated quantities are the total, non-elastic scattering, elastic and inelastic scattering, radiation capture, (n,p), (n,t), (n,2n), (n,a) reaction cross sections and the angular distributions of elastic and inelastic cross sections. Some of the data were calculated with the program AUJP based on the optical model and the program MUP2 based on the Hauser-Feshbach model and pre-equilibrium evaporation model. (author). 34 refs, 8 figs, 3 tabs.

20738 **Half-life of ^{56}Co.** Alburger, D.E. (Brookhaven National Laboratory, Upton, New York 11973 (USA)); Warburton, E.K.; Tao, Z. *Physical Review [Section] C: Nuclear Physics (USA)*, 40(6): 2789-2792 (Dec 1989). DOE Contract AC02-76CH00016.

The half-life of ^{56}Co has been determined in one series of experiments by simultaneously measuring the decay of the 847-keV γ-ray line relative to the 662-keV line of ^{137}Cs and the decay of the 1238-keV line relative to the 1275-keV line of ^{22}Na in a Ge(Li) γ-ray detector. Data were taken for two half-lives of ^{56}Co. In a second series of runs, covering one ^{56}Co half-life, the decay of the 847-keV line was measured relative to the 898-keV γ ray of ^{88}Y. By combining the results we obtain $T_{1/2}$=77.30(9) d for the half-life of ^{56}Co.

20739 **New gamma ray in the decay of ^{56}Co.** Alburger, D.E. (Brookhaven National Laboratory, Upton, New York 11973 (USA)); Warburton, E.K.; Tao, Z. *Physical Review [Section] C: Nuclear Physics (USA)*, 40(6): 2891-2892 (Dec 1989). DOE Contract AC02-76CH00016.

A reexamination of the γ-ray spectrum of ^{56}Co has revealed a previously unobserved transition of 852.78(5) keV decaying with the ^{56}Co half-life. Its intensity is 0.050(3) relative to I_{847}=100. Alternate explanations for this peak, such as summing, have been ruled out and the γ ray is assigned as the 4298.0(4+)→3445.3(3+) transition in ^{56}Fe with a branching ratio of 1.4(1)%. Assuming an $M1$ assignment and a negligible $E2$ component, we find $B(M1)=6.5(30)\times10^{-3}$ W.u., which lies between the $B(M1)$ values for the other two $M1$ transitions from the 4298-keV state.

6516 Nuclear Properties and Reactions, A = 59-89, Experimental

Refer also to citation(s) 20736, 20993

6517 Nuclear Properties and Reactions, A = 90-149, Experimental

Refer also to citation(s) 20736

20740 (CEA-CONF–9856) **Search for nuclear disassembly in the Ne+Ag and Ne+Au systems at 60 MeV/u.** Cassagnou, Y. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Physique Nucleaire); Dayras, R.; Legrain, R.; Peter, J.; Pollacco, E.C.; Volant, C.; Wieleczko, J.P.; Bizard, G.; Louvel, M.; Motobayashi, S. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Physique Nucleaire. 1989. 4p. (CONF-8904153–: Symposium on nuclear dynamics and nuclear disassembly, Dallas, TX (USA), 9-14 Apr 1989). Order Number DE90752526. Available from NTIS (US Sales Only), PC A02/MF A01.

For sufficiently energetic collisions between heavy ions, a number of theoretical studies predict the existence of a multifragmentation process where the system disintegrates into massive and numerous fragments. What is particularly disturbing is that the approaches use very different assumptions ranging from transition between liquid-gas phases, cold break-up, statistical decay of hot nuclei to simple consideration of the available phase-space and yet are to a large extent, capable to represent the data reasonably well. We have set an objective to perform measurements where it might be possible to choose between the different mechanisms. In this contribution we report on preliminary results on the reactions Ne+Au and Ne+Ag at 60 MeV/A using the Neon beam provided by the GANIL facility.

20741 (CONF-890902–27) **High spin spectroscopy for odd-Z nuclei with A ≈ 160.** Yu, C.-H. (Niels Bohr Inst., Copenhagen (Denmark)); Gascon, J.; Hagemann, G.B.; Garrett, J.D. Oak Ridge National Lab., TN (USA). [1989]. 38p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 198. American Chemical Society national meeting; Miami, FL (USA); 10-15 Sep 1989. Order Number DE90007882. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Experimental routhians, alignments, band crossing frequencies, and the B(M1)/B(E2) ratios of the N = 90 isotones and several light Lu (N = 90–96) isotopes are summarized and discussed in terms of shape changes. This systematic analysis shows a neutron- and proton-number dependent quadrupole and γ deformations for these light rare earth nuclei. The stability of the nuclear deformation with respect to β and γ is also found to be particle-number dependent. Such particle-number dependent shapes can be attributed to the different locations of the proton and neutron Fermi levels in the Nilsson diagrams. Configurations dependent shapes are discussed specially concerning the deformation difference between the proton

$h_{9/2}$ $\frac{1}{2}^-$[541] and the high-K $h_{11/2}$ configurations. The observed large neutron band crossing frequencies in the $h_{9/2}$ $\frac{1}{2}^-$[541] configuration support the predicted large deformation of this configuration, but can be reproduced by the self-consistent cranked shell model calculation. Lifetime measurement for ^{157}Ho, one of the nuclei that show such a large $\hbar\omega_c$ in the $\frac{1}{2}^-$[541] band, indicates that deformation difference can only account for 20% of such shift in $\hbar\omega_c$. 55 refs., 12 figs.

20742 (DOE/ER/10495–T1) **Transitional nuclei in the A∼100 region: Final report, August 1, 1979–August 31, 1986.** Petry, R.F. Oklahoma Univ., Norman, OK (USA). [1986]. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AS05-79ER10495. Order Number DE90007416. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This is a report on nuclear structure studies funded by the Department of Energy over a seven-year period from August 1, 1979 to August 31, 1986. In summary, the work was concerned with nuclear structure in the A∼100 region. In particular the focus of the work was on odd-A deformed nuclei in this region with N > 60.

20743 **Evidence for radial-energy scaling of nonequilibrium neutron yield in damped ^{139}La+^{40}Ar reactions.** Wile, J.L. (Department of Chemistry and Physics and Nuclear Structure Research Laboratory, University of Rochester, Rochester, New York 14627 (US)); Datta, S.S.; de Souza, R.T.; Huizenga, J.R.; Pade, D.; Schroder, W.U.; Toke, J. *Physical Review Letters (USA)*, 63(23): 2551-2554 (4 Dec 1989).

Emission patterns of neutrons from damped ^{139}La+^{40}Ar reactions at E_{lab}=400 and 600 MeV, mostly consistent with sequential evaporation from accelerated fragments, reveal the existence of a high-energy component at all kinetic energy losses. The average multiplicity associated with this nonequilibrium component is found to scale with the radial kinetic energy at contact, with a threshold of E_{rad}≈2 MeV/nucleon. Boltzmann-master-equation and Fermi-jet models disagree with the data, the latter model requiring enhanced high-momentum components.

20744 **Angular momentum effects in subbarrier fusion of ^{64}Ni+^{100}Mo.** Halbert, M.L. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831 (USA)); Beene, J.R.; Hensley, D.C.; Honkanen, K.; Semkow, T.M.; Abenante, V.; Sarantites, D.G.; Li, Z. *Physical Review [Section] C: Nuclear Physics (USA)*, 40(6): 2558-2575 (Dec 1989). DOE Contract AC05-84OR21400.

Angular momentum distributions σ_l for the compound nucleus ^{164}Yb were deduced from measurements of γ-ray multiplicity for all significant evaporation residues from fusion of ^{64}Ni and ^{100}Mo. At the lowest bombarding energies the σ_l extend to higher *l* values than do predictions of barrier-penetration models that include coupling of the principal inelastic channels, even if the coupling strengths are increased to match the experimental excitation function. Likewise, σ_l from a real potential with an energy-dependent shape fitted to the excitation function fails to reproduce the experimental σ_l distribution. Better success is achieved with models in which fusion occurs at large distances.

20745 **Search for reflection asymmetric structures in the *A*≈145 mass region: Decays of 1.8-s ^{143}Cs to levels of ^{143}Ba and 4.1-s ^{147}La to levels of ^{147}Ce.** Robertson, J.D. (Department of Chemistry, University of Maryland, College Park, Maryland 20742 (US)); Mantica, P.F. Jr.; Faller, S.H.; Stone, C.A.; Baum, E.M.; Walters, W.B. *Physical Review [Section] C: Nuclear Physics (USA)*, 40(6): 2804-2822 (Dec 1989).

The level structures of ^{143}Ba and ^{147}Ce have been investigated by studying the β decays of 1.8-s ^{143}Cs and 4.1-s ^{147}La to search for evidence of intrinsic reflection asymmetry in light rare-earth nuclei. Gamma-ray energies and relative intensity values, γ-γ coincidence intensities, and γ-γ angular correlation coefficients were measured. The parity doublets that characterize reflection asymmetric rotational structures in the light odd-*A* actinides were not readily identified in ^{143}Ba or ^{147}Ce. The observed level structures, combined with other data for these nuclides, suggest that weak deformation is present and that reflection asymmetric admixtures may play a significant role in driving that deformation.

6518 Nuclear Properties and Reactions, A = 150-189, Experimental

Refer also to citation(s) 20993

20746 (CEA-CONF–9857) **Disintegration of the nuclear system formed in the 45 MeV/Nucleon ^{84}Kr + ^{159}Tb reaction.** Dayras, R. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Physique Nucleaire); Wieleczko, J.P.; Barreto, J.; Auger, G.; Plagnol, E.; Schutz, Y.; Majka, Z.; Sobotka, L.G.; Stracener, D.W.; Saratites, D.G. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Physique Nucleaire. 1989. 10p. (CONF-8904153–: Symposium on nuclear dynamics and nuclear disassembly, Dallas, TX (USA), 9-14 Apr 1989). Order Number DE90752525. Available from NTIS (US Sales Only), PC A02/MF A01.

The occurrence of exit channels for which no massive remnant of either the target or projectile is established for 45 MeV/Nucleon ^{84}Kr reaction on ^{159}Tb. Up to 11 intermediate mass fragments were detected in coincidence with high multiplicity of light charge particles. Several characteristics of multifragment exit channels are investigated.

20747 (CONF-8908129–5) **Squids, supercurrents, and slope anomalies: Nuclear structure from heavy-ion transfer reactions.** Guidry, M.W. Tennessee Univ., Knoxville, TN (USA). Dept. of Physics. [1989]. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-87ER40361. From 12. workshop on nuclear physics; Iguazu Falls (Argentina); 28 Aug - 1 sep 1989. Order Number DE90007338. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Within the past five years we have developed experimental techniques to study heavy-ion transfer reactions to high spin states in deformed nuclei. These methods have been turned into a quantitative tool to assess the influence of collective excitation on single-particle and pairing structure. I discuss some of the nuclear structure questions which are being answered in these experiments: How strong is ground state pairing? How does pairing change with angular momentum? Why is two-neutron transfer much stronger than expected at large radial separation? What is the evidence for a nuclear Josephson Effect? What is the evidence for a nuclear Berry phase effect (nuclear SQUID)? Why does one-neutron transfer populate much higher spins than would be naively expected? Conversely, why does two-neutron transfer populate much lower spins than anyone expected? The answer to each of these questions involves the influence of detailed nuclear structure on transfer reactions, and represents quantitative new information about the effect of angular momentum and excitation energy on many-body systems with a finite number of particles. 8 refs., 6 figs.

20748 (CONF-8909247–4) **High spin spectroscopy for A ≈ 160 nuclei.** Yu, C.-H. (Niels Bohr Inst., Copenhagen (Denmark)); Gascon, J.; Garrett, J.D.; Hagemann, G.B. Tennessee Univ., Knoxville, TN (USA). Dept. of Physics and Astronomy. [1989]. 38p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-87ER40361. From ACS symposium on exotic nuclear spectroscopy; Miami Beach, FL (USA); 11-15 Sep 1989. Order Number DE90007058. Available from NTIS, PC A03/MF A01; OSTI; INIS.

Experimental routhians, alignments, band crossing frequencies, and the B(M1)/B(E2) ratios of the N = 90 isotopes and several light Lu (N = 90–96) isotopes are summarized and discussed in terms of shape changes. These systematic analyses show a neutron and proton number dependent deformations (both quadruple and γ deformations) for these light rare earth nuclei. The stability of the nuclear deformation with respect to β and γ is also found to be particle number dependent. Such particle number dependent shapes can be attributed to the different locations of the proton and neutron Fermi levels in the Nilsson diagrams. Configurations dependent shapes are discussed specially concerned the deformation difference between the proton $h_{9/2}1/2^-$[541] and the high-K $h_{11/2}$ configurations. The observed large neutron band crossing frequencies in the $h_{9/2}1/2^-$[541] configuration support the predicted large deformation of this configuration but can be reproduced by the cranked shell model calculation according to the predicted deformations. Lifetime measurement for ^{157}Ho, one of

the nuclei that show a large $\hbar\omega^c$ in the $1/2^-[541]$ band, indicates that deformation difference can only account for 20% of such shift in $\hbar\omega_c$. 55 refs., 12 figs.

6519 Nuclear Properties and Reactions, A = 190-219, Experimental

Refer also to citation(s) 20740

20749 (BNL–43674) **BNL high energy heavy ion experiments.** Miake, Yasuo. E-802 Collaboration; ANL-BNL-UCBerkeley-UCRiverside-Columbia-Hiroshima-INS-Kyushu-LLNL-MIT-Tokyo Collaboration. Brookhaven National Lab., Upton, NY (USA). [1989]. 9p. Sponsored by U.S. DOE Energy Research; US-Japan High Energy Physics Collaboration Treaty. DOE Contract AC02-76CH00016. (CONF-8909299–1: 5. French-Japanese symposium on nuclear physics, Dogashima (Japan), 26-30 Sep 1989). Order Number DE90006061. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This paper discusses the measurement of particle spectra and correlations with good particle identification and with various triggers, such as selection of charged multiplicity, neutral energy and forward energy.

20750 (CONF-890826–9) **Transverse momentum distributions of neutral pions from ^{16}O + Au collisions at 200 GeV/nucleon.** Plasmil, F. (Oak Ridge National Lab., TN (USA)); Awes, T.C.; Baktash, C.; Ferguson, R.L.; Lee, I.Y.; Sorensen, S.; Obenshain, F.E.; Albrecht, R.; Bock, R.; Claesson, G. WA80 Collaboration. Oak Ridge National Lab., TN (USA). [1989]. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-87ER40361;AC05-84OR21400. From International nuclear physics conference; Sao Paulo (Brazil); 20-26 Aug 1989. Order Number DE90007340. Available from NTIS, PC A02/MF A01; OSTI; INIS.

One means of studying the properties of the compressed and highly excited reaction zone is the investigating of p_T spectra of produced pions and their dependence on the centrality of the reaction. To distinguish different contributing processes and to provide a reliable basis for comparisons with p+p scattering, a large p_T coverage is required. In particular, data at high p_T values, where hard processes become important and may be calculated by perturbative QCD, are of interest. The present study of π^0 spectra concentrates on measurements of p_T spectra up to 2.8 GeV/c and on selections of the data according to the centrality of the reaction. 2 refs., 6 figs.

20751 **Observation of superdeformed bands in ^{194}Hg.** Beausang, C.W. (Lawrence Livermore National Lab., CA (USA)); Henry, E.A.; Becker, J.A.; Roy, N.; Yates, S.W.; Deleplanque, M.A.; Diamond, R.M.; Stephens, F.S.; Draper, J.E.; Kelly, W.H. *Zeitschrift fuer Physik A: Atomic Nuclei (Germany, F.R.)*, 335(3): 325-330 (Mar 1990). DOE Contract W-7405-ENG-48;AC03-76SF00098;AC05-84OR21400.

Two rotational bands, with energy spacings characteristic of superdeformed shapes, have been observed following bombardment of ^{150}Nd with ^{48}Ca. The more intensively populated band consists of 18 transitions and is assigned to ^{194}Hg. The depopulation of this band occurs around spin 10. The second band, consisting of at least 16 transitions, was populated less strongly and is tentatively assigned to ^{194}Hg also. The lowest level in this band is assigned spin 8. The energy differences between transitions for both bands decrease from $\simeq$ 40 keV at low rotational frequencies to $\simeq$ 30 keV at the highest observed frequencies. The moments of inertia of the bands are similar to those of the two previously observed superdeformed bands in $^{191,192}Hg$. The similarities and differences of the four known bands in the mercury region are discussed. (orig.).

20752 **Dynamics of collective excitations in $^{190,192}Os$ and ^{194}Pt observed by 8 MeV neutron scattering.** Clegg, T.B. (Centre d'Etudes de Bruyeres-le-Chatel, 91680, Bruyeres-le-Chatel, (France)); Haouat, G.; Delaroche, J.P.; Lagrange, C.; Chardine, J.; McEllistrem, M.T.; Hicks, S.E.; Shen, G.R. *Physical Review [Section] C: Nuclear Physics (USA)*, 40(6): 2527-2540 (Dec 1989).

Differential cross sections have been measured for the scattering of 8 MeV neutrons from $^{190,192}Os$ and ^{194}Pt. These measurements have been combined with information from other neutron scattering experiments to fix accurately the electric quadrupole and octupole excitations strengths for low-lying levels. Comparison of this information with electromagnetic excitations for these same nuclei elucidates the rapidly evolving behavior of low-lying collective structures in Pt and Os nuclei. The ^{194}Pt excitations are those of a nucleus with a potential energy surface very soft to nonaxial deformations. On the other hand, the scattering cross sections for excited levels of ^{190}Os show evolution of excitations toward those of a nucleus vibrating about a prolate equilibrium shape.

6520 Nuclear Properties and Reactions, A = 220 and Above, Experimental

Refer also to citation(s) 20764, 20765

20753 (GSI–89-85(prepr.)) **Reactions of ^{40}Ar with ^{233}U, ^{235}U, and ^{238}U at the barrier.** Scherer, U.W. (Mainz Univ. (Germany, F.R.). Inst. fuer Kernchemie); Frink, C.; Kratz, J.V.; Trautmann, N.; Herrmann, G.; Gaeggeler, H.; Bruechle, W.; Bruegger, M.; Moody, K.J.; Schaedel, M. Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.). Dec 1989. 26p. Order Number DE90753573. Available from NTIS (US Sales Only), PC A03/MF A01.

Production cross sections for target-like transfer products in reactions of ^{40}Ar with $^{233,235,238}U$ at the barrier were determined using radiochemical techniques. The heaviest products dtected are isotopes of californium (Z=98). In addition to the quasi-elastic component of the isotopic distributions observed in the vicinity of uranium, there are also relaxed contributions of this component for fixed atomic number, after the transfer of >3 charges, approach closely the minimum of the potential energy surfaces (PES). The experimental results thus indicate the cold formation of the reaction products. A search for long-lived heavy actinides produced, by fusion-evaporation, via isotopes of element 110 and their subsequent decay through α-decay chains, remained unsuccessful at a cross section limit of 21 pb. (orig.).

20754 (HMI-B–464, pp. 10) **Neutron induced heavy ion emission and neutron induced ternary fission with heavy third particle.** Boersig, B. (Tuebingen Univ. (Germany, F.R.)); Goennenwein, F.; Loeffler, H.; Geltenbort, P. Hahn-Meitner-Institut Berlin G.m.b.H. (Germany, F.R.). Feb 1989. (CONF-890491–: International conference on fifty years of research in nuclear fission, Berlin (Germany, F.R.), 3-7 Apr 1989). In *International conference on fifty years research in nuclear fission. Contributed papers.* Order Number DE90749132. Available from NTIS (US Sales Only), PC A06/MF A01.

Published in summary form only. URANIUM 233 TARGET/thermal fission; URANIUM 233 TARGET/neutron reactions; URANIUM 234/heavy ion emission decay; THERMAL FISSION/ternary fission; NEUTRON REACTIONS/knock-out reactions; FISSION FRAGMENTS; EXPERIMENTAL DATA; LIMITING VALUES; ENERGY SPECTRA; LIFETIME; Q-VALUE; BRANCHING RATIO; NEON 24; LEAD 210

20755 (HMI-B–464, pp. 51) **Ternary fission of neutron induced uranium fissioning isomers.** Makarenko, V.E. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii (Moscow)); Molchanov, Yu.D.; Otroshenko, G.A.; Yankov, G.B. Hahn-Meitner-Institut Berlin G.m.b.H. (Germany, F.R.). Feb 1989. (CONF-890491–: International conference on fifty years of research in nuclear fission, Berlin (Germany, F.R.), 3-7 Apr 1989). In *International conference on fifty years research in nuclear fission. Contributed papers.* Order Number DE90749132. Available from NTIS (US Sales Only), PC A06/MF A01.

Published in summary form only. URANIUM 236 TARGET/neutron reactions; URANIUM 236/spontaneous fission; URANIUM 238 TARGET/neutron reactions; URANIUM 238/spontaneous fission; NEUTRON REACTIONS/inelastic scattering; SPONTANEOUS FISSION/ternary fission; BRANCHING RATIO; EXCITED STATES; EXCITATION; FAST NEUTRONS; ISOMERIC NUCLEI; MEV RANGE 01-10; NUCLEAR REACTION YIELD; FISSION ISOMERS; BINARY FISSION; FISSION RATIO; HALF-LIFE; EXPERIMENTAL DATA

20756 (PSI–49) **First results from gaschemistry experiments with hahnium.** Gaeggeler, H.W. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Jost, D.T.; Baltensperger, U. Paul Scherrer Inst. (PSI), Wuerenlingen (Switzerland). Nov 1989. 19p. Order Number DE90615628. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Gaschemistry experiments in quartz columns were performed with products from the reaction $^{18}O + {}^{249}Bk$ at E ≈ 98 MeV. HBr/BBr_3 was used as reactive gas. The temperature was varied between 300 and 600 C. Final products were assayed for alpha- and for spontaneous fission decay. The procedure was sensitive to nuclides with half-lives down to about 10 s. In the range 8.35 through 8.75 MeV 162 alpha-events were detected. A decay analysis gives a half-life of 33 ± 6 which is consistent with the nuclide ^{262}Ha ($T_{1/2}$ = 35 s) and its alpha-decaying daughter ^{258}Lr ($T_{1/2}$ = 4.35 s). Since too few alpha-alpha correlations were found it was not possible to definitely assign these observed alpha-events to this decay chain. The low number of observed correlated events may be explained by the very non-ideal large deposits of final samples in the counting device. Highest count-rates of this alpha-event group were found at 400 C, distinctly different from alpha-activities originating from actinide isotopes. The chromatographic behaviour of this alpha-event group resembles that of a bromide species with a volatility between those of the more volatile niobium and the less volatile tantalum bromides, respectively. If these alpha-events indeed mainly belong to ^{262}Ha the simultaneously measured fission events give evidence that this nuclide has a much lower fission branch (le25%) than believed so far. Instead, a new fission activity with $T_{1/2} \simeq$ 15s was found which behaves like a trans-actinide element. (author) 14 figs., 1 tab., 20 refs.

20757 **Direct proof of electron-capture–delayed-fission process.** Hall, H.L.; Gregorich, K.E.; Henderson, R.A.; Gannett, C.M.; Chadwick, R.B.; Leyba, J.D.; Czerwinski, K.R.; Kadkhodayan, B.; Kreek, S.A.; Lee, D.M. *Physical Review Letters (USA)*, 63(23): 2548-2550 (4 Dec 1989). DOE Contract AC03-76SF00098.

We have studied electron capture followed by delayed fission in ^{234}Am. The half- life of ^{234}Am was determined to be 2.32±0.08 min and the measured ratio of delayed fissions to plutonium *K* x rays was $(6.6\pm1.8)\times10^{-5}$. The observed fissions were unequivocally assigned to an electron-capture–delayed-fission process in americium by coincidence measurements between the *K*-capture x rays and the subsequent fission.

20758 **Half-life of ^{229}Th.** Goldstein, S.J. (Isotope Geochemistry, Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (USA)); Murrell, M.T.; Williams, R.W. *Physical Review [Section] C: Nuclear Physics (USA)*, 40(6): 2793-2795 (Dec 1989).

Isotope dilution mass spectrometry was used to measure the concentration of ^{229}Th in the National Bureau of Standards ^{229}Th radioactivity standard, Standard Reference Material 4328. From these data the half-life of ^{229}Th is determined to be 7880±120 yr. This value is approximately 7% greater than the presently accepted value of 7340±160 yr.

6530 Nuclear Theory

Refer also to citation(s) 20732, 20735, 20752

20759 (CEA-CONF–9842) **A third minimum in the fission barrier.** Blons, J. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique Nucleaire a Basse Energie. 1989. 21p. (CONF-890491–: International conference on fifty years of research in nuclear fission, Berlin (Germany, F.R.), 3-7 Apr 1989). Order Number DE90752546. Available from NTIS (US Sales Only), PC A03/MF A01.

The latest refinements of the fission barrier pinpointed the occurrence of a third minimum. This paper reviews the search for such a minimum through high energy resolution fission probability measurements. After successful experiments with neutrons, deuteron beams were used. Higher J spin members of a pair of rotational bands with opposite parities were found, in the (d,pf) experimental results, as expected. The experimental fission barrier parameters are compared to the theoretical calculations obtained from the macroscopic-microscopic model and the purely microscopic one. The properties of nuclei at the third minimum deformation are also discussed.

20760 (CONF-900418–5) **Reich-Moore and Adler-Adler representations of the ^{235}U cross sections in the resolved resonance region.** de Saussure, G. (Oak Ridge National Lab., TN (USA)); Leal, L.C.; Perez, R.B. Oak Ridge National Lab., TN (USA). [1990]. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From International conference on the physics of reactors: operation, design and computation; Marseilles (France); 23-26 Apr 1990. Order Number DE90006153. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In the first part of this paper, a reevaluation of the low-energy neutron cross sections of ^{235}U is described. This reevaluation was motivated by the discrepancy between the measured and computed temperature coefficients of reactivity and is based on recent measurements of the fission cross section and of η in the thermal and subthermal neutron energy regions. In the second part of the paper, we discuss the conversion of the Reich-Moore resonance parameters, describing the neutron cross sections of ^{235}U in the resolved resonance region, into equivalent Adler-Adler resonance parameters and into equivalent momentum space multipole resonance parameters. 25 refs., 4 figs., 5 tabs.

20761 (CONF-8909247–5) **Dynamical symmetries for fermions.** Guidry, M. Tennessee Univ., Knoxville, TN (USA). Dept. of Physics. 1989. 22p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-87ER40361. From ACS symposium on exotic nuclear spectroscopy; Miami Beach, FL (USA); 11-15 Sep 1989. Order Number DE90007339. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

An introduction is given to the Fermion Dynamical Symmetry Model (FDSM). The analytical symmetry limits of the model are then applied to the calculation of physical quantities such as ground-state masses and $B(E_2)$ values in heavy nuclei. These comparisons with data provide strong support for a new principle of collective motion, the Dynamical Pauli Effect, and suggest that dynamical symmetries which properly account for the pauli principle are much more persistent in nuclear structure than the corresponding boson symmetries. Finally, we present an assessment of criticisms which have been voiced concerning the FDSM, and a discussion of new phenomena and "exotic spectroscopy" which may be suggested by the model. 14 refs., 8 figs., 4 tabs.

20762 (DOE/ER/40376–3) **Microscopic heavy-ion theory: Progress report, February 1989–January 1990.** Oberacker, V.E.; Umar, A.S. Vanderbilt Univ., Nashville, TN (USA). Dept. of Physics and Astronomy. [1990]. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-87ER40376. Order Number DE90007420. Available from NTIS, PC A02/MF A01; OSTI; INIS.

We report the research activities of the theoretical nuclear physics group at Vanderbilt University during the period February 1989 to January 1990 under contract FG05-87ER40376 with the Department of Energy. Ongoing research projects include three-dimensional static and time-dependent Hartree-Fock studies of low energy heavy-ion reactions and nuclear structure, nonperturbative electromagnetic lepton pair production in relativistic heavy-ion collisions in connection with RHIC, study of fission dynamics via prompt muon-induced fission, a semi-classical time-dependent external field model for the study of prompt nucleon emission, and the relativistic generalization of the collective model. Computational aspects of our work encompass the basis-spline collocation method for the accurate lattice solution of boundary value differential equations and relaxation methods for the numerical solution of the Schroedinger and Dirac equations. This report is composed of abstracts of papers.

20763 (INDC(CCP)–307/L) **Parametrization of mass curve of neutron-induced actinide fission products.** Goverdovsky, A.A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk (USSR). Fiziko-Ehnergeticheskij Inst.). International Atomic Energy Agency, Vienna (Austria). International Nuclear Data Committee. Nov 1989. 9p. Order Number DE90617137. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Regardless of advances in the theory of fission, the description of mass fragment yields is at a comparatively low level, which in

particular manifests itself in the design mass dispersions being essentially less than those observed for neutron induced fission of actinides. This results in significant errors of predicting independent yields essential for practical purposes. Certain approaches to the evaluation of isotopic and energy dependences of actinide fission fragment mass distributions are discussed in this paper. 15 refs, 4 figs.

20764 (INDC(CCP)–309/N) **The operations research as an instrument for analysis and planning of nuclear-spectroscopic experiment.** Chukreev, F.E. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Atomnoj Ehnergii). International Atomic Energy Agency, Vienna (Austria). International Nuclear Data Committee. Dec 1989. 12p. Order Number DE90617134. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The procedure of nuclear-spectroscopic data analysis by the operations research methods is presented. The fragment of ^{239}Pu decay is considered as an example of application. The conclusion is drawn on nonconformity between experimental data and the adopted system of ^{235}U levels. (author). 6 refs, 2 figs.

20765 (INDC(GDR)–056/L) **Prompt neutron emission in nuclear fission.** Seeliger, D. (Technische Univ., Dresden (German Democratic Republic)); Kalka, H.; Maerten, H.; Ruben, A.; Arnold, K.; Duering, I. International Atomic Energy Agency, Vienna (Austria). International Nuclear Data Committee. Oct 1989. 12p. Order Number DE90617138. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Experimental results obtained in recent fragment-neutron correlation measurements are the basis for a detailed analysis of neutron emission characteristics in conjunction with several statistical-model approaches: (i) temperature distribution model (applied calculations), (ii) standard evaporation theory I (Weisskopf-Ewing approach extended by a rough angular momentum correction term), (iii) standard evaporation theory II (Hauser-Feshbach type calculations including angular momentum effects), (iv) statistical multistep compound theory (closed-form description including equilibrium as well as non-equilibrium emissions). All emission models account for an intricate fragment occurrence probability distribution in nucleon numbers, excitation energy, kinetic energy, and (except models (i) and (iv)) angular momentum. They have been used to predict yields, energy and angular distributions as well as representative c.m.s. spectrum shape parameters in the case of 252-Cf spontaneous fission in order to study the mechanisms of prompt fission neutron emission and several features of statistical emission. Model (iv) describes the development of the fragment compound system as a stochastic process starting at scission point and, hence, considering emission processes during fragment acceleration. The results of all model calculations indicate a clear predominance of the evaporation mechanism. The possible role of secondary mechanisms and difficulties in deducing information about them are discussed. The present paper gives a review on all four models. Results obtained within standard evaporation theory II (full-scale Hauser-Feshbach calculation) are discussed in more detail. (author). 27 refs, 4 figs.

20766 (INDC(TUK)–002/L) **Empirical formulae for 14.5 MeV (n,p) cross sections.** Selvi, S. (Ege Univ., Izmir (Turkey). Physics Dept.); Erbil, H.H. International Atomic Energy Agency, Vienna (Austria). International Nuclear Data Committee. Dec 1989. 6p. Order Number DE90617106. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Six empirical formulae of the (n,p) cross sections for 14.5-MeV neutrons were obtained with respect to even and odd (N-Z) values, depending on the effective Q-Value, the Coulomb barrier height, the threshold and incident neutron energies and the mass number of the target. These formulae were compared with the experimental values. The present calculations fit the experimental results quite well compared to those predicted by the previous workers. (author). 8 refs, 1 fig., 1 tab.

20767 (Juel–2295) **Intranuclear cascade evaporation model predictions of double differential A(p,xn) neutron cross sections and comparison with experiments at 318 MeV and 800 MeV proton energy.** Cloth, P. (Kernforschungsanlage Juelich GmbH (Germany, F.R.). Inst. fuer Kernphysik); Dragovitsch, P.; Filges, D.; Reul, C.; Amian, W.B.; Meier, M.M. Kernforschungsanlage Juelich GmbH (Germany, F.R.). Inst. fuer Kernphysik. Aug 1989. 51p. Order Number DE90753664. Available from NTIS (US Sales Only), PC A04/MF A01.

The intranuclear-cascade evaporation model as implemented in the high energy radiation transport code HETC, subsystem of HERMES is used in the calculation of double differential cross sections of proton induced neutron production. The investigations were done on target elements C, Al, Ta, Ni, W, Pb, and U at 318 MeV incident proton energy and on C, Al, Pb, and U at 800 MeV, respectively. The predictions of the INCE model were compared with experimental data for double differential cross sections taken at 7.5 and 30 degrees scattering angles at the Los Alamos WNR facility utilizing the Time of Flight technique at LANL. The calculations performed here are part of a experimental-theoretical program within the LANL-KFA collaboration concerning medium energy cross section measurements mainly neutrons and state of the art computer code validations of these measurements. In general, the model predictions reproduce the correct neutron production for evaporation neutrons and are also in good agreement with the experimental data at high neutron energies. In the energy range dominated by preequilibrium processes an underestimation of experimental yields has to be remarked. (orig.).

20768 (LA-UR–89-3386) **Validation of aggregate delayed neutron spectra calculated from precursor data.** Brady, M.C. (Oak Ridge National Lab., TN (USA)); England, T.R. Los Alamos National Lab., NM (USA); Oak Ridge National Lab., TN (USA). [1989]. 12p. Sponsored by U.S. DOE Energy Research; Japan Atomic Energy Research Institute. DOE Contract W-7405-ENG-36;AC05-84OR21400. (CONF-900418–2: International conference on the physics of reactors: operation, design and computation, Marseilles (France), 23-26 Apr 1990). Order Number DE90002390. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

An extensive reference library of delayed neutron data has been compiled which contains fission yields and branchings, delayed neutron emission probabilities, and spectra for 271 precursors. These data have been used to calculate the aggregate behavior of delayed neutrons following a fission event in 43 fissioning systems. Least-squares techniques were used to produce fitted decay constants and abundances in the conventional six-group formalism from these calculated activity curves. A consistent set of six-group spectra have also been calculated for each of the fissioning systems. Recent measurements at the University of Lowell have produced measured energy spectra for delayed neutrons following the thermal fission (T) of ^{235}U and ^{239}Pu, and the fast fission (F) of ^{238}U. These measured spectra provide data that may be used to validate the precursor data base and the fitted six-group data. This summary presents results of this validation effort. Both the individual precursor data and the six-group data have been used to calculate aggregate equilibrium spectra for ^{235}U(T), ^{238}U(F), and ^{239}Pu(T) via summation techniques. The important precursors in each case are identified, and the status of their data reviewed. 8 refs., 3 figs., 3 tabs.

20769 (LA-UR–90-1) **Global nuclear-structure calculations.** Moeller, P.; Nix, J.R. Los Alamos National Lab., NM (USA). [1990]. 2p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-900450–1: Nuclear structure in the '90's, Oak Ridge, TN (USA), 23-27 Apr 1990). Order Number DE90006483. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This paper compares theoretical models of nuclear structure with experimental measurements. 4 figs.

20770 **Time-dependent density-matrix theory. Pt. 2. Mass dispersion in damped nuclear reactions.** Gong, M. (National Superconducting Cyclotron Lab., East Lansing, MI (USA)); Tohyama, M.; Randrup, J. *Zeitschrift fuer Physik A: Atomic Nuclei (Germany, F.R.),* 335(3): 331-340 (Mar 1990). DOE Contract AC03-76SF00098.

The mass fluctuations in damped reactions of ^{16}O+^{16}O are studied in an extended time-dependent Hartree-Fock theory. The theory determines the time evolution of a two-body density matrix as well as that of a one-body density matrix, providing us with a

microscopic way to calculate the fluctuations of one-body quantities. The results of the theory are compared with those obtained in a transport model. It is found that the dispersions in fragment mass calculated in the two models are of the same order of magnitude and much larger than those calculated in the time-dependent Hartree-Fock theory. The differences between the microscopic theory and the transport model are also discussed. (orig.).

20771 Polarization observables in deuteron photodisintegration and electrodisintegration. Dmitrasinovic, V. (College of Willam and Mary, Williamsburg, Virginia 23185 (USA)); Gross, F. *Physical Review [Section] C: Nuclear Physics (USA),* 40(6): 2479-2497 (Dec 1989).

A comprehensive relativistic treatment of polarization observables in deuteron photo- and electrodisintegration is presented from a unified standpoint. A discussion of necessary and sufficient measurements needed for a complete determination of all transition amplitudes is given.

20772 Equilibrium cluster emission from ^{3}He+Ag reactions. Blann, M. (Physics Department, Lawrence Livermore National Laboratory, Livermore, California (USA)); Komoto, T.T.; Tserruya, I. *Physical Review [Section] C: Nuclear Physics (USA),* 40(6): 2498-2508 (Dec 1989). DOE Contract W-7405-ENG-48.

Cluster emission yields from ^{3}He reactions on Ag targets are analyzed using Hauser-Feshbach theory with the hybrid preequilibrium decay model. The importance of multiple chance cluster emission is investigated, as well as sensitivity to assumptions of ground-state versus excited cluster emission. The importance of sequential decay is explored qualitatively. Calculations using an equal fragment/residue temperature limit plus preequilibrium decay, and those using a ground-state cluster emission/preequilibrium decay assumption bracket the experimental excitation functions, however, with up to several orders of magnitude difference between these upper and lower limit results.

20773 Relativistic transport theory of fluctuating fields for hadrons. Siemens, P.J. (Oak Ridge National Laboratory, P.O. Box 2008, Oak Ridge, Tennessee 37831 (US)); Soyeur, M.; White, G.D.; Lantto, L.J.; Davies, K.T.R. *Physical Review [Section] C: Nuclear Physics (USA),* 40(6): 2641-2671 (Dec 1989).

We analyze the physics of relativistic nuclear collisions and demonstrate that an adequate treatment of pions must include the quantum time-energy uncertainty principle and nonsequential three-body collisions. We apply relativistic quantum field theory to obtain exact equations determining the time evolution of hadronic fields and their fluctuations in terms of the effective interactions describing scattering in matter. These equations relate the main physical observables to the sought-after properties of nuclear matter, and involve only these quantities and the corresponding properties of free-space one- and two-body processes. We show how to regularize the singularities by employing the internal structure of the mesons, while maintaining causality and unitarity. We show that, in a very good approximation, the dynamic quantities reduce to functions of eight variables—those of the Boltzmann equation, supplemented by the energy of the hadron. Our method appears capable of deducing the properties of hot dense nuclear matter from data already measured in experiments on the collisions of heavy nuclei.

20774 Collisional relaxation in simulations of heavy-ion collisions using Boltzmann-type equations. Welke, G. (Physics Department, State University of New York at Stony Brook, Stony Brook, New York 11794 (USA)); Malfliet, R.; Gregoire, C.; Prakash, M.; Suraud, E. *Physical Review [Section] C: Nuclear Physics (USA),* 40(6): 2611-2620 (Dec 1989).

We compare three test-particle methods currently used in numerical simulations of Boltzmann-type equations for the analysis of intermediate-energy heavy-ion collisions with an exact solution of the Krook-Wu model. These methods are the full ensemble, parallel ensemble, and hybrid techniques. We find that collisional relaxation is sensitive to the method of simulation used. The full ensemble approach is found to agree with the exact results of the Krook-Wu model. The parallel ensemble procedure provides a reasonable approximation to the analytical relaxation rate for a wide range of systems, while the hybrid method overestimates the relaxation rate. We further compare transverse flow data from the first two of these methods in a cascade simulation of heavy-ion collisions, and find reasonable agreement provided the two-body cross section is not enhanced by a large factor over its free space value. This has implications for quantitative comparisons of calculations to experimental data.

20775 T_{20} problem and spin observables in pion-deuteron scattering. Mizutani, T. (Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061 (USA)); Fayard, C.; Lamot, G.H.; Saghai, B. *Physical Review [Section] C: Nuclear Physics (USA),* 40(6): 2763-2779 (Dec 1989).

There has been a long-standing problem in the coupled πNN-NN theory concerning its apparent failure in reproducing the tensor polarization T_{20} in the elastic πd scattering at medium energies. A mechanism recently proposed by Jennings to solve this problem is examined. It is then found that it comes from the positive-energy pole in one of the nucleon propagators in the exchange impulse diagram within the covariant picture which is usually overlooked when devising the spectator on-mass-shell approximation, and that it does not lead to the claimed near cancellation of the Pauli exchange contribution, but is important to be included. The inclusion of this contribution is shown to considerably improve in reproducing the pion-deuteron spin observables including T_{20}, particularly above the delta resonance energy.

20776 Shell-model study of ^{39}S(β^-)^{39}Cl and the energy levels of ^{39}Cl. Warburton, E.K. (Brookhaven National Laboratory, Upton, New York 11973 (US)— Physikalisches Institut der Universitaet Heidelberg and Max-Planck-Institut fuer Kernphysik, D-6900 Heidelberg, Germany, F.R.); Becker, J.A. *Physical Review [Section] C: Nuclear Physics (USA),* 40(6): 2823-2833 (Dec 1989).

Shell-model calculations are performed for the odd- and even-parity states of ^{39}Cl and the odd-parity states of ^{39}S. The ^{39}S odd-parity states and the ^{39}Cl even-parity states were considered in full $(1s,0d)^{20}(0f,1p)^3$ and $(1s,0d)^{21}(0f,1p)^2$ configurational spaces, respectively. For the ^{39}Cl odd-parity states it was necessary to use a highly truncated $(1s,0d)^{20}(0f,1p)^3$ configurational space. The method and results of truncation are discussed in some detail. Observables calculated include energy spectra, binding energies, ^{40}Ar→^{39}Cl+p spectroscopic factors, first-forbidden and allowed β^- decay of ^{39}S, and γ transitions in both ^{39}S and ^{39}Cl. Results are compared to experiment. For example, the spectroscopic factors for $1/2^+$ and $3/2^+$ ^{39}Cl states and the γ transitions between the even-parity ^{39}Cl states are predicted with high accuracy while the half-life of ^{39}S is calculated to be 5.6 s (if the spin-parity of ^{39}S has the preferred value of $7/2^-$) as compared to the experimental value of 11.5±0.5 s.

20777 $Sp_6 \leq crSscrU_2$ symmetry of the fermion dynamical symmetry model. Chen, J. (China Center of Advanced Science and Technology (World Laboratory) Beijing, (China)); Chen, X.; Feng, D.H.; Wu, C.; Ginocchio, J.N. *Physical Review [Section] C: Nuclear Physics (USA),* 40(6): 2844-2861 (Dec 1989).

The $SP_6 \times SU_2$ symmetry of the fermion dynamical symmetry model (FDSM) was studied. Analytic expressions are given for the wave functions and matrix elements of the pair creation operators $S^\dagger$, $D^\dagger$, and $E2$ transition operator for the heritage u=0, 1, 2 cases. Various Pauli effects which differentiate the FDSM SU_3 from IBM SU_3, as well as the relationship between the wave functions and matrix elements in the FDSM, the interacting boson model, the Sp(6,R) models, and the Elliott model are discussed. Extensive discussions of the physical implications of the model are presented.

20778 Triton model calculation test of the Bonn W-matrix rank-one approximation. Gibson, B.F. (Theoretical Division, Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (USA)); Pearce, B.C.; Payne, G.L. *Physical Review [Section] C: Nuclear Physics (USA),* 40(6): 2877-2880 (Dec 1989).

The rank-one separable part of the W-matrix representation of the t matrix for the Malfliet-Tjon I-III nucleon-nucleon potential has been shown to lead to results for the triton binding energy and low-energy ($E_{lab} \leq 50$ MeV) nucleon-deuteron scattering that agree well with results for that potential obtained by solving the full local-potential equations. We explore why this prescription appears to

work so well for the Malfliet-Tjon I-III model and test it further using the Reid-soft-core spin-singlet interaction, which possesses a very strong short-range repulsion (a stiff core). For this model, a calculation using the rank-one separable part of the *W*-matrix representation of the two-body *t* matrix overbinds the triton by 25%.

20779 **Observables in kaon photoproduction.** Workman, R.L. (Department of Physics, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061 (US)). *Physical Review [Section] C: Nuclear Physics (USA)*, 40(6): 2922-2923 (Dec 1989).

We briefly review the status of recent analyses of kaon photoproduction data. The utility of future measurements of other kaon photoproduction observables is discussed. We note that a set of target polarization data has been neglected in all recent analyses. The constraint imposed by this data set is illustrated.

20780 **Reply to "Comment on 'Nonresonant capture of low-energy protons by ^{27}Al' ".** Hardie, G. (Western Michigan University, Kalamazoo, Michigan 49008 (USA)); Segel, R.E.; Elwyn, A.J.; Monahan, J.E. *Physical Review [Section] C: Nuclear Physics (USA)*, 40(6): 2929 (Dec 1989).

We reply to the preceding Comment.

6540 Radiation and Shielding Physics

Refer also to citation(s) 19910, 20611, 20616, 20623, 20971, 21010

20781 (JAERI-M–89-122) **Review of the presented papers for the 7th international conference on radiation shielding.** Sasamoto, Nobuo (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Aoki, Tamotsu; Ando, Yasumasa. Japan Atomic Energy Research Inst., Tokyo (Japan). Sep 1989. 78p. (In Japanese). Order Number DE90749878. Available from NTIS (US Sales Only), PC A05/MF A01.

The 7th International Conference on Radiation Shielding (ICRS7) was held in Bournemouth, UK, from September 12 to 16, 1988. In this report, 133 technical papers presented to the ICRS7 were reviewed, as a work of the Shielding Subcommittee of the Research Committee on Reactor Physics. In reviewing them, special attentions were paid on their main themes, originarities, specific features, conclusions and/or their applicability to actual shield designs. (author).

20782 (LA–11680-MS) **Quick, reliable estimates of high-power microwave fluences: The SNEAKY-II program.** Tunnell, T.W. (EG and G Energy Measurements, Inc., Los Alamos, NM (USA)); Roussel-Dupre, R. Los Alamos National Lab., NM (USA). Jan 1990. 38p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. Order Number DE90006347. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The propagation of high-power microwave pulses through the atmosphere is often modeled with time-dependent fluid or kinetic codes that require a fine mesh of range and time points. The computational time to run these codes precludes their use to determine the optimum pulse characteristics and propagation paths for delivery of a desired fluence to a specified target. In this work, a universal, parameterized scaling law for microwave-induced air breakdown is integrated into the SNEAKY model to produce a new microwave propagation code, SNEAKY-II. It estimates microwave fluences to within 1%–13% agreement with the more elaborate time-dependent fluid codes while running a hundred to several thousand times faster. The purpose of this report is to document the SNEAKY-II code, complete with benchmarking and specifications of the inherent limitations. 5 refs., 17 figs., 3 tabs.

20783 (SLAC-PUB–5170) **Viewing MORSE-CG radiation transport with 3-D color graphics.** Namito, Yoshihito; Jenkins, T.M.; Nelson, W.R. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jan 1990. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (CONF-900343–2: Supercomputing in nuclear applications, Mito City (Japan), 12-16 Mar 1990). Order Number DE90006455. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

In this paper we present the coupling of MORSE-CG with the SLAC Unified Graphics System (UGS77) through an add-on package called MORSGRAF which allows for real-time display of neutron and photon tracks in the Monte Carlo simulation. In addition to displaying the myriad of complicated geometries that can be created with the MORSE Combinatorial Geometry program, MORSGRAF permits color tagging of neutrons (green) and photons (red) with the variation of track intensity an indicator of the energy of the particle. Particle types can be switched off and on by means of a mouse-icon system, and the perspective can be changed (i.e., rotated, translated, and zoomed). MORSGRAF also allows one to display the propagation of radiation through shields and mazes on an ordinary graphics terminal, as well as in documents printed on a laser printer. Several examples will be given to demonstrate the various capabilities of MORSGRAF coupled to MORSE-CG. 12 refs., 8 figs.

20784 (SLAC-PUB–5193) **The EGS4 Code System: Solution of gamma-ray and electron transport problems.** Nelson, W.R.; Namito, Yoshihito. Stanford Linear Accelerator Center, Menlo Park, CA (USA). 9 Feb 1990. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (CONF-900343–3: Supercomputing in nuclear applications, Mito City (Japan), 12-16 Mar 1990). Order Number DE90008100. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In this paper we present an overview of the EGS4 Code System – a general purpose package for the Monte Carlo simulation of the transport of electrons and photons. During the last 10-15 years EGS has been widely used to design accelerators and detectors for high-energy physics. More recently the code has been found to be of tremendous use in medical radiation physics and dosimetry. The problem-solving capabilities of EGS4 will be demonstrated by means of a variety of practical examples. To facilitate this review, we will take advantage of a new add-on package, called SHOWGRAF, to display particle trajectories in complicated geometries. These are shown as 2-D laser pictures in the written paper and as photographic slides of a 3-D high-resolution color monitor during the oral presentation. 11 refs., 15 figs.

20785 (UCID–21814) **Fast algorithms for calculating laser wavefront phase compensation given noisy measurements of phase gradient.** Gavel, D. Lawrence Livermore National Lab., CA (USA). Sep 1989. 50p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-48. Order Number DE90006357. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Laser light propagating through atmosphere will become distorted as a result of the changing index of refraction along the light path. Wavefront distortions can be actively compensated using adaptive optic systems, which sense the wavefront aberations and compensate by changing the shape of a reflecting surface. Corrections must be done rapidly in order to keep up with the variations in the atmosphere. Numerically, the calculation of the correcting surface is a least-squares fit problem. However, since a typical adaptive optic system has a large number of actuators and sensors, the ordinary solution methods, such as Gaussian elimination, are infeasible for real time application. Instead, we must take advantage of the structure and "sparseness" of the equations in order to speed up the calculation. The algorithm proposed in this report requires only O(nq) calculation steps and uses only O(n) memory storage, where n is the total number of actuators and q is the "influence width" of a single actuator. The derivation of the proposed algorithm, proofs of convergence, and results of several test runs are presented in this report. The algorithm has been incorporated into Y division's ORACLE simulation code where it is used to calculate the phase conjugate surfaces necessary to precompensate a high powered laser beam for atmospheric propagation. 12 refs., 10 figs., 2 tabs.

20786 (UCRL–101807) **Sparse breakdown and statistical "sneakthrough" effects in low-altitude microwave propagation.** Alvarez, R.A.; Bolton, P.R.; Sieger, G.E.; Fittinghoff, D.N. Lawrence Livermore National Lab., CA (USA). Jan 1990. 8p. Sponsored by U.S. Department of Defense; U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. AFWL-89-079. (CONF-891097–4: High powered microwave and broadband radio

frequency propagation/phenomenology/methodology workshop, Livermore, CA (USA), 23-26 Oct 1989). Order Number DE90007252. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

It is generally assumed that the beam intensity that can be transmitted through the atmosphere by a high-power microwave pulse will be limited by the air-breakdown threshold. Air breakdown by microwave has been studied extensively, both theoretically and experimentally. It is a cascade process in which free electrons, driven by the microwave electric field, generate further ionization through collisions with air molecules. The process can disrupt the propagation of a microwave pulse if the electron plasma density grows to within an appreciable fraction of critical density. In a pulsed beam this can happen if, and only if, the field strength is sufficiently large and the beam encounters one or more initiating free "seed" electrons sufficiently early in the pulse. This paper discusses this sparse breakdown in low-altitude wave propagation.

20787 (UM-P–89/34) **Fizeau-type experiments with neutrons.** Cimmino, A. (Melbourne Univ., Parkville (Australia). School of Physics); Hamilton, W.A.; Klein, A.G.; Opat, G.I.; Arif, M.; Clothier, R.; Kaiser, H.; Werner, S.A. Melbourne Univ., Parkville (Australia). School of Physics. [1989]. 4p. Order Number DE90617071. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

In 1951 Fizeau performed an experiment on the change of phase of lightwaves induced by the motion of a refracting medium inserted in a Rayleigh-type optical interferometer. It is seen today as a classical confirmation of Einstein's velocity addition formula of special relativity. The analogous experiments performed with neutrons highlight certain peculiarities which arise when the de Broglie waves associated with massive particles traverse a moving medium. The phase shifts which arise when a moving medium is introduced into a neutron interferometer differ from those which would occur for a classical wave. Three such analogous experiments are briefly reported. Each involved the placing of rapidly rotating objects inside neutron interferometers and confirmed theoretical predictions. 16 refs.

6550 Medical Physics

Refer also to citation(s) 20208, 20310, 20311, 20312, 20313, 20314, 20315, 20316, 20317, 20318, 20319, 20320, 20321, 20322, 20344, 20448, 20464

20788 (DOE-RW–89.070) **Guide to the dynamic biosphere model DECOS (Ed. 1).** Nancarrow, D.J. (Associated Nuclear Services, Epsom (UK)); Mitchell, B.H. Department of the Environment, London (UK). Apr 1988. 64p. Contract PECD-7/9/191. (ANS-R–595-12). Order Number DE90617676. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

A dynamic biosphere model, DECOS, has been developed by Associated Nuclear Sevices Ltd for the Department of the Environment. DECOS was written as a 'stand-alone' development code to be interfaced with other assessment models as part of a new probabilistic code, VANDAL. This report provides a guide to the 'stand-alone' version of DECOS. (author).

20789 (IPEN-PUB–213) **Iodine-131 urinalyses data interpretation according to ICRP-35.** Duarte, C.L.; Gaburo, J.C.G.; Rangel, E.P. Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo, SP (Brazil). Oct 1988. 14p. (In Portuguese). Order Number DE90617678. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In this paper is presented a statistical survey of the data obtained from Iodine-131 analysis in urine for individual internal monitoring between 1982 and 1986, among the workers of the Radioisotope Processing Department of the IPEN-CNEN/SP. The evaluation of these data was made in accordance with the recommendation of ICRP-35 and were stablished the levels of reference: Recording, Investigation and Intervention. Then is discussed the radioprotection policy to be addopted when the levels of reference are reached and finally were evaluated the conditions of the working place. (author).

20790 (NPL-RSA(EXT)–3) **The NPL survey on tritium and radon standards.** Makepeace, J.; Curry, M. National Physical Lab., Teddington (UK). Feb 1989. 10p. Order Number DE90617663. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The survey was carried out to establish the ranges of activity and levels of uncertainty which would satisfy U.K. customers' needs for Tritium and Radon standards in gas and water. A secondary object was to obtain comments on needs for other standards. (U.K.).

20791 (OEFZS–4499, pp. 1-3) **The OENORM S 5200 'Radioactivity in building materials' as a tool for radiation protection of the general population.** Kunsch, B. (Oesterreichisches Forschungszentrum Seibersdorf G.m.b.H. (Austria). Inst. fuer Physik); Steger, F.; Tschirf, E. Oesterreichisches Forschungszentrum Seibersdorf G.m.b.H. (Austria). Apr 1989. (PH–468/89;ST–165/89). In *The OENORM S 5200 'Radioactivity in building materials' as a tool for radiation protection of the general population.* Order Number DE90617643. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The Austrian Standard OENORM S 5200 provides criteria to assess the radiation dose from building materials. It takes the gamma radiation of the radionuclides K-40, Th-232 and Ra-226 into account, as well as the dose due to the noble gas Radon, which is released from building materials after decay of Radium. A building material is considered acceptable if its dose rate in a room does not exceed 2 mSv/a. Provisions are made to minimise the required experimental effort to prove compliance with the Standard. 6 refs. (Author).

20792 (SAAS–378) **Dose assessment and radioprotective medical evaluation of prenatal radiation exposures to diagnostic X-rays.** Bruening, L.; Haehnel, S.; Arndt, D. Staatliches Amt fuer Atomsicherheit und Strahlenschutz, Berlin (German Democratic Republic). 1989. 19p. (In German). Order Number DE90617679. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The 2nd to 15th weeks after conception are assessed to be the critical time period for the induction of teratogenic radiation damage. In the GDR, women having incurred fetal doses in excess of 100 mGy are recommended to interrupt pregnancy. Of 275 patients advised in the National Board for Atomic Safety and Radiation Protection between 1978 and 1988, approximately 90% were found to have received fetal doses below 20 mGy. Only 4 women had been exposed to doses above 100 mGy. Exposure data were given in the form of tables, and discussed. (author).

6560 Condensed Matter Physics

Refer also to citation(s) 19797, 19895, 19908, 19910, 20129, 20222, 20223, 20616, 20646, 20951, 20954, 20961, 21065

20793 (CEA-CONF–9523) **Beyond quasiperiodicity: scaling properties of a Fourier spectrum.** Godreche, C. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique du Solide et de Resonance Magnetique. Mar 1988. 4p. (CONF-8803125–: Universalities in condensed matter physics workshop, Les Houches (France), Mar 1988). Order Number DE90752597. Available from NTIS (US Sales Only), PC A02/MF A01.

We try to study how the quasiperiodicity of an one-dimensional structure can be destroyed and what are the consequences of the disappearance of the average lattice on the Fourier spectrum.

20794 (CEA-CONF–9524) **Universality classes of fluctuating membranes.** Peliti, L. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique Theorique. Mar 1988. 7p. (CONF-8803125–: Universalities in condensed matter physics workshop, Les Houches (France), Mar 1988). Order Number DE90752598. Available from NTIS (US Sales Only), PC A02/MF A01.

The current interest in the statistical mechanics of fluctuating surfaces is emphasized. The identification of the universality classes of fluctuating surfaces is not yet satisfactorily understood, by contrast with the ease of the fluctuating chains. The importance of making the difference between fluid and crystalline surfaces is underlined. The local geometrical properties of a surface are considered. The concept of rigid (or smooth) fluid surfaces is discussed. The phase

behavior of the resulting system, concerning the effects of self-avoidance on an ensemble of fluid membranes, is analyzed. The connection between crystalline and fluid membranes is suggested.

20795 (CEA-CONF–9529) **Solitary waves, Baecklund transformation from the Painleve analysis in the Kuramoto-Sivashinsky equation.** Conte, R. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique du Solide et de Resonance Magnetique); Musette, M. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique du Solide et de Resonance Magnetique. 1987. 14p. (CONF-8711335–: RCP Meeting Inverse Problems, Montpellier (France), 30 Nov - 4 dec 1987). Order Number DE90752595. Available from NTIS (US Sales Only), PC A03/MF A01.

We apply the Painleve test to the Kuramoto-Sivashinsky nonlinear partial differential equation, which describes many interesting fluid motions. The equation passes the test in a weak sense. Although the Painleve analysis does not yield the general solution, we perform the Baecklund transformation in order to obtain new particular solutions. We find explicitly all the solutions of the set of equations which define the Painleve-Baecklund transformation: they reduce to only one type, namely the already known stationary wave in the form of a kink-shaped 1-soliton.

20796 (CEA-CONF–9847) **Experimental aspects of S.H.I.C. (Swift Heavy Ion Channeling).** Quere, Y. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Section d'Etude des Solides Irradies); Mory, J.; Andriamonje, S.; Anne, R.; Castro Faria, N.V. de; Chevallier, M.; Gaillard, M.J.; Genre, R.; Farizon-Mazuy, B.; Poizat, J.C. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Section d'Etude des Solides Irradies. 1989. 3p. (CONF-8905283–: Symposium on Swift Heavy Ions in Matter (SHIM 89'), Caen (France), 16-19 May 1989). Order Number DE90752560. Available from NTIS (US Sales Only), PC A02/MF A01.

Also published in CEN/BG–8918.

We have studied the behaviour of swift heavy ions, of initial charge Z_0, transmitted in a crystal. More precisely we have measured, for various values of Z_0, the mean stopping power experienced by the ions of exit charge Z, together with the charge distribution n(Z). In this short note, we describe briefly the instrumental set-up, and give two specific results which make it possible to appreciate the accuracy and sensitivity of the experiment.

20797 (DOE/ER/45291–3) **Optical studies of dynamical processes in disordered materials: Progress report.** Yen, W.M. Georgia Univ., Athens, GA (USA). Dept. of Physics and Astronomy. Dec 1989. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract FG09-87ER45291. Order Number DE90007080. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We have presented a brief narrative of the progress we have attained to date in relaxation and transfer studies, in the identification and determination of the nature of the sites of Cr ions in the disordered phases of ceramics and in the study of the optical properties of fibers, inclusive of attempts to localize a single atom in a glass. We intend to pursue a number of continuing studies in the second period of this grant: (1) attempts to stimulate energy transfer process, (2) continued attempts to isolate a single ion in a fiber, and (3) exploitation of the fiber configuration for spectroscopic purposes. We again emphasize that our discussion has been abbreviated and is meant principally to convey a sense of the directions we have been undertaking. 12 refs.

20798 (DOE/ER/45319–T1) **[Fundamental studies of new magnetic heterostructures: Their growth, crystallographic structure, magnetic and electronic properties]: Progress report.** Onellion, M. (Wisconsin Univ., Madison, WI (USA). Dept. of Physics); Dowben, P.A. Wisconsin Univ., Madison, WI (USA). Dept. of Physics. [1990]. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-87ER45319. Order Number DE90007381. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

As part of our request for renewal of our grant, we include this progress report on the significant results obtained under grant number FG02-89ER45319, "Fundamental Studies of New Magnetic Heterostructures: Their Growth, Crystallographic Structure, Magnetic and Electronic Properties," since the inception of the grant. The results include the scientific accomplishments, the instrumentation developed, and the technological applications of our work. Each area is discussed separately and an initial summary of all areas is provided before the detailed discussion.

20799 (EUR-CEA-FC–1362, pp. 77-80) **Thermodesorption of graphite exposed to a deuterium plasma.** Grosman, A. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee); Gauthier, E.; Bardon, J.; Palmari, J.P. Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. 1989. (CONF-890302–: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *EURATOM-CEA Association Contributions to the 16. European Conference on Controlled Fusion and Plasma Physics.* Order Number DE90752562. Available from NTIS (US Sales Only), PC A05/MF A01.

The results obtained by implanting pyrolitic and polycrystalline samples of graphite with a deuterium plasma source, are reported. The density of the plasma is 5.10^{12} cm^{-3} and the electronic temperature is 15 eV. After the plasma exposure, the samples are: analysed by thermodesorption with different heating rates. The experimental set-up consists in one plasma source and one thermodesorption device. The graphite sample can be moved without breaking vacuum from the plasma source to the analysis apparatus. Two series of experiments are effectuated: with the sample directly screwed on the support; and with the sample electrically and thermally isolated from the support. The peak temperatures for different heating rates are given. The experiments done with pyrolytic graphite gave the same results for the peak positions and the general features of the spectra, due to a temperature rise during the bombardment. The diffusion process numerical simulation gives peaks with a tail at the left side for second order desorption and at the rightside for the diffusion mechanism. Independent measurements of the diffusion coefficients seems to be necessary for a choice of one mechanism.

20800 (IPEN-PUB–269) **Quasielastic neutron scattering study of the localized diffusion of hydrogen in $Ti_{0.8}$ $Zr_{0.2}$ $CrMnH_3$.** Mestnik Filho, J.; Vinhas, L.A. Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo, SP (Brazil). Oct 1989. 17p. Order Number DE90616726. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The localized diffusion of hydrogen in the storage compound $Ti_{0.8}$ $Zr_{0.2}$ $CrMnH_3$ was studied by quasielastic slow neutron scattering with the berillium-filter-time-of-flight spectrometer. A large quasi elastic width was detected which is more than one order of magnitude larger than that observed for long range diffusion, in an experimental situation in which the observed correlation lenght was the same as the mean jump lenght for hydrogen diffusion. (author).

20801 (IPEN-PUB–274) **Refinement of the ferri and paramagnetic phases of magnetite measured by neutron multiple diffraction.** Mazzochi, V.L.; Parente, C.B.R. Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo, SP (Brazil). Oct 1989. 19p. (In Portuguese). Order Number DE90616727. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Structural parameters of the ferri and paramagnetic phases of magnetite have been refined from neutron multiple diffraction data. Experimental patterns were obtained by measuring the III primary reflection of a natural single crystal of this compound, at room temperature for the ferrimagnetic phase and 703°C for the paramagnetic phase. Theoretical multiple diffraction patterns for both phases have been calculated by the program MULTI which uses the iterative method. In this method intensities are caluclated as Taylor series expansions summed up to a order sufficient for a good approximation. A step by step process has been used in the refinements similarly to the parameter-shift method. Final values for the discrepancy factor found for the ferri and paramagnetic phases were R = 3.96% and R = 3.46%, respectively. (author).

20802 (KEK–89-5, pp. 104-109) **Mechanism of luminescence from CeF_3 excited by VUV photons and ionizing charged particles.** Kubota, Shinzou (Rikkyo Univ., Tokyo (Japan)); Ruan, Jian-Zhi; Hashimoto, Satoshi; Sakuragi, Shiro. National Lab.

for High Energy Physics, Tsukuba, Ibaraki (Japan). Jul 1989. (CONF-8901178–: 4. workshop on radiation detectors and their uses, Tsukuba (Japan), 24-25 Jan 1989). In *Radiation detectors and their uses*. Order Number DE90741444. Available from NTIS (US Sales Only), PC A08/MF A01.

Two luminescence bands of 290 nm and 390 nm in CeF_3 are observed. The 290 nm band corresponds to the transitions from the localized 5d states of Ce^{3+} to the 4f states irrespective of the excitation of 5d, 6s and 5p states of Ce^{3+}. The lifetime for the 290 nm band was found to be 4 $\pm$ 1 ns, and no temperature dependence of the lifetime was observed in the region of 77 - 300K. The 390 nm band has no fast component. (author).

20803 (KU-HCOE-FL2-R–88-5) **Phase distributions in rapidly solidified stainless steels.** Grabaek, L. (Copenhagen Univ. (Denmark). Fysisk Lab.); Johnson, E.; Wood, J.V. Copenhagen Univ. (Denmark). H.C. Oersted Inst. 1988. 32p. Order Number DE90616729. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Phase distributions and the internal magnetic fields have been determined in rapidly solidified stainless steels (Fe-nCr-8Ni-0.05C, Fe-nCr-5Ni and Fe-nCr with n in the range 10-24) by transmission and conversion electron Moessbauer spectroscopy (TMS and CEMS). Based on these results, a modification of the phase boundaries in the Schaeffler diagram is suggested, to account in particular for rapidly solidified stainless steels. The suggested modification is primarily an expansion of the austenite field towards higher Cr and lower Ni equivalent content. Combining CEMS and TMS makes it possible to determine the phase distributions both in the near surface region (outmost 300 nm) and in the bulk of the ribbons. For the low Cr alloys the content of bcc-phase (martensite) in the surface region is higher than in the sample as a whole. In the high Cr alloys the content of bcc-phase (ferrite) is lower in the surface than in the bulk. This disparity is ascribed to the different mechanisms of formation of martensite (diffusionless) and ferrite (nucleation and growth), in relation to the higher cooling rates of the surface layers. (orig.).

20804 (KU-HCOE-FL2-R–88-6) **Mechanism of plateau formation in the fractional quantum Hall effect.** Bruus, H.; Hansen, O.P.; Hansen, E.B. Copenhagen Univ. (Denmark). H.C. Oersted Inst. 18 Feb 1988. 21p. Order Number DE90616797. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Laughlin's fractionally charged quasi-holes and quasi-electrons are assumed to be pinned, and to be subject to a force j vectorxPhi_0 vector from the transport current. A force balance argument then explains the existence of Hall plateaus. (orig.).

20805 (KU-HCOE-FL2-R–88-7) **Martensitic transformations in 304 stainless steel after implantation with helium, hydrogen and deuterium.** Johnson, E. (Copenhagen Univ. (Denmark). Fysisk Lab.); Grabaek, L.; Johansen, A.; Sarholt-Kristensen, L.; Boergesen, P.; Scherzer, B.M.U.; Hayashi, N.; Sakamoto, I. Copenhagen Univ. (Denmark). H.C. Oersted Inst. 1988. 24p. Order Number DE90616798. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Using conversion electron Moessbauer spectroscopy (CEMS) and glancing angle X-ray diffraction, martensitic transformations have been studied in type 304 austenitic stainless steels implanted with 8 keV helium, hydrogen and deuterium. Furthermore, using CEMS in the energy selective mode (DCEMS), the distribution of martensite in the implantation zone has been analysed as a function of depth. Transformation of the implanted layer occurs after implantation with 10^{21} m^{-2} He^+ ions while 100 times higher fluence is required for the implanted layer to transform after hydrogen or deuterium implantations. This difference is due to the ability of helium to form high pressure gas bubbles, while implanted hydrogen is continuously lost by back diffusion to the surface. The helium bubbles, which are confined under pressures as high as 60 GPa, will induce extremely high stress levels in the implanted layer, by which the martensitic transformation is directly induced. The fact that a much higher fluence of hydrogen or deuterium is required to induce the transformation, shows that radiation damage plays only a minor role. In this case, the martensitic transformation first occurs when the implanted layer resembles the state of a cathodically charged surface. (orig.).

20806 (KU-HCOE-FL2-R–88-10) **X-ray studies of krypton, xenon and lead inclusions in aluminium single crystals.** Grabaek, L. (Risoe National Lab., Roskilde (Denmark)); Bohr, J.; Johnson, E.; Andersen, H.H.; Johansen, A.; Sarholt-Kristensen, L. Copenhagen Univ. (Denmark). H.C. Oersted Inst. 1988. 17p. Order Number DE90616796. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Samples of aluminum single crystals with [111] normal were implanted with either Kr, Xe or Pb. The small inclusions formed due to the immiscibility of these elements and aluminum were then studied by X-ray diffraction at various temperatures. The analysis showed that the small noble gas inclusions ($\simeq$ 23 A) formed after implantation are solid up to at least 541 Kelvin. During the first heating cycle the inclusions grow and in a second heating cycle it is found that the largest of the inclusions ($\simeq$ 42 A) melt below 260 Kelvin. The lead inclusions grow during the first and the second temperature cycle. Gradual melting was observed in a temperature interval from 621-660 Kelvin, which is above 603 Kelvin, the melting temperature of bulk lead. (orig.).

20807 (KU-HCOE-FL2-R–88-11) **Depth distribution analysis of martensitic transformations in Xe implanted austenitic stainless steel.** Johnson, E. (Copenhagen Univ. (Denmark). Fysisk Lab. (Denmark)); Johansen, A.; Sarholt-Kristensen, L.; Gerritsen, E.; Keetels, H.A.A.; Chechenin, N.G.; Grabaek, L.; Bohr, J. Copenhagen Univ. (Denmark). H.C. Oersted Inst. 1988. 19p. Order Number DE90616728. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In this work we present results from a depth distribution analysis of the martensitic phase change occurring in Xe implanted single crystals of austenitic stainless steel. Analysis was done by 'in situ' RBS/channeling analysis, X-ray diffraction and cross-section transmission electron microscopy (XTEM) of the implanted surface. It is found that the martensitic transformation of the surface layer occurs for fluences above $1x10^{20}$ m^{-2}. The thickness of the transformed layer increases with fluence to $\simeq$ 150 nm at $1x10^{21}$ m^{-2}, which far exceeds the range plus straggling of the implanted Xe as calculated by the TRIM computer simulation code. Simulations using the MARLOWE code indicate that the thickness of the transformed layer coincides with the range of the small fraction of ions channeled under random implantation conditions. Using cross sectional TEM on the Xe implanted crystals, the depth distribution of gas inclusions and defects can be directly observed. Using X-ray diffraction on implanted single crystals, the solid epitaxial nature of the Xe inclusions, induced prior to the martensitic transformation, was established. The lattice constant obtained from the broad diffraction peak indicates that the pressure in the inclusions is $\simeq$ 5 GPa. (orig./BHO).

20808 (KU-HCOE-FL2-R–89-8) **The internal strain parameter of diamond from synchrotron radiation measurements.** Cousins, C.S.G. (Exeter Univ. (UK). Dept. of Physics); Sheldon, B.J.; Gerward, L.; Staun Olsen, J. Copenhagen Univ. (Denmark). H.C. Oersted Inst. 1989. 25p. Order Number DE90616734. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The internal strain parameter of diamond has been found from the uniaxial-stress-dependence of the integrated intensity of the 'forbidden' 006 reflection. Synchrotron radiation from the storage ring DORIS-HASYLAB was conditioned by a gold mirror to provide the 006 and 008 reflections from the sample. Integrated intensities were recorded using an energy-dispersive method. The value found is anti A=-0.031$\pm$0.005 and corresponds to a bond-bending parameter zeta=0.125$\pm$0.020. This value is in accord with two recent theoretical values based on a bond-charge model and on an ab initio pseudopotential calculation. (orig.).

20809 (KU-HCOE-FL2-R–89-9) **Scaling concepts in simulated annealing.** Sibani, P. (Odense Univ. (Denmark). Fysisk Inst.); Moerch Pedersen, J.; Hoffmann, K.H.; Salamon, P. Copenhagen Univ. (Denmark). H.C. Oersted Inst. 1989. 17p. Order Number DE90616735. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We show that the density of states and the distribution of extremes of energy seen in a given time interval for simulated annealing problems are strongly related to each other through the first passage time probability density of the stochastic dynamics of

the system. We then introduce a scaling ansatz for this last quantity, and check its predictions for a graph bipartitioning problem. The ansatz allows for a run time estimate of the ground state of the problem, thus implicitly yielding a stopping criterion for the annealing schedule. (orig.).

20810 (KU-HCOE-FL2-R-89-10) **The internal strain parameter of gallium arsenide measured by energy-dispersive X-ray diffraction.** Cousins, C.S.G. (Exeter Univ. (UK). Dept. of Physics (United Kingdom)); Sheldon, B.J.; Webster, G.E.; Gerward, L.; Selsmark, B.; Staun Olsen, J. Copenhagen Univ. (Denmark). H.C. Oersted Inst. 1989. 20p. Order Number DE90616730. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The internal strain parameter of GaAs has been measured by observing the stress-dependence of the integrated intensity of the weak 006 reflection, with the compressive stress along the [1anti 10] axis. An energy-dispersive technique was employed so that the reflection could be obtained at a photon energy close to the minimum in the structure factor, thereby approaching closely the strictly-forbidden condition that applies at any energy in the diamond structure. A value anti A=-0.138±0.005, equivalent to a bond-bending parameter zeta=0.55=0.02, has been found. This is in good agreement with recent theoretical calculations and indirect determinations related to the bandstructure of GaAs. (orig.).

20811 (KU-HCOE-FL2-R-89-11) **An RVB state with fermionic charges and bosonic spins: Mean field theory.** Flensberg, K.; Hedegard, P.; Brix Pedersen, M. Copenhagen Univ. (Denmark). H.C. Oersted Inst. 1989. 13p. Order Number DE90616731. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We consider a representation of the Hubbard model, in which the charge carriers are fermions and the spin carriers are bosons. We show that there exist a mean-field solution with a condensate of spin-singlets and we characterize the low temperature behavior of the quasiparticles. Finally we calculate the tunneling spectrum for a normal metal-RVB state tunnel junction and suggest the tunneling experiment as a probe of the statistics of the RVB quasiparticles. (orig.).

20812 (KU-HCOE-FL2-R-89-12) **Finite-time thermodynamics and simulated annealing.** Andresen, B. (Copenhagen Univ. (Denmark). Fysisk Lab.). Copenhagen Univ. (Denmark). H.C. Oersted Inst. 1989. 13p. (CONF-8902161–: 4. conference on irreversible processes and self-organization, Rostock (German Democratic Republic), 19 Feb 1989). Order Number DE90616732. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

When the general, global optimization technique simulated annealing was introduced by Kirkpatrick et al. (1983), this mathematical algorithm was based on an analogy to the statistical mechanical behavior of real physical systems like spin glasses, hence the name. In the intervening span of years the method has proven exceptionally useful for a great variety of extremely complicated problems, notably NP-problems like the travelling salesman, DNA sequencing, and graph partitioning. Only a few highly optimized heuristic algorithms (e.g. Lin, Kernighan 1973) have outperformed simulated annealing on their respective problems (Johnson et al. 1989). Simulated annealing in its current form relies only on the static quantity 'energy' to describe the system, whereas questions of rate, as in the temperature path (annealing schedule, see below), are left to intuition. We extent the connection to physical systems and take over further components from thermodynamics like ensemble, heat capacity, and relaxation time. Finally we refer to finite-time thermodynamics (Andresen, Salomon, Berry 1984) for a dynamical estimate of the optimal temperature path. (orig.).

20813 (KU-HCOE-FL2-R-89-15) **Superheating and supercooling of lead precipitates in aluminium.** Grabaek, L. (Risoe National Lab., Roskilde (Denmark). Physics Dept.); Bohr, J.; Johnson, E.; Johansen, A.; Sarholt-Kristensen, L.; Andersen, H.H. Copenhagen Univ. (Denmark). H.C. Oersted Inst. 1989. 17p. Order Number DE90616733. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In situ X-ray diffraction studies of the melting and solidification of small crystalline precipitates of lead in an aluminum single crystal show both superheating and supercooling. This gave rise to a hysteresis loop between melting and solidification. The hysteresis loop persisted over successive heating cycles demonstrating that it is genuine in its physical existence. The width of the hysteresis loop decreased from 88 K to 62 K as the mean size of the lead inclusions grew from 141 A to 275 A. The observed growth took place during subsequent heating cycles. The phenomenon of superheating and supercooling are thus more pronounced for the smaller lead crystallites. We discuss the results in a phenomenological context considering the lack of free surfaces of the lead crystallites. (orig.).

20814 (LA-UR-90-668) **Muzzle shunt augmentation of conventional railguns.** Parker, J.V. Los Alamos National Lab., NM (USA). 1990. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-9004136–3: 5. IEEE symposium on electromagnetic launch technology, Destin, FL (USA), 1-5 Apr 1990). Order Number DE90007505. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Augmentation is a well-known technique for reducing the armature current and hence the armature power dissipation in a plasma armature railgun. In spite of the advantages, no large augmented railguns have been built, primarily due to the mechanical and electrical complexity introduce by the extra conductors required. It is possible to achieve some of the benefits of augmentation in conventional railgun by diverting a fraction ϕ of the input current through a shunt path at the muzzle of the railgun. In particular, the relation between force and armature current is the same as that obtained in an n-turn, series connected augmented railgun with $n = 1/(1-\phi)$. The price of this simplification is a reduction in electrical efficiency and some additional complexity in the external electrical system. Additions to the electrical system are required to establish the shunt current and to control its magnitude during projectile acceleration. The relationship between muzzle shunt augmentation and conventional series augmentation is developed and various techniques is developed and various techniques for establishing and controlling the shunt current are illustrated with a practical example. 5 refs., 8 figs., 2 tabs.

20815 (ORNL/FTR-3527) **[Modern theory of magnetism]: Foreign trip report, January 10, 1990–January 24, 1990.** Liu, S.H. Oak Ridge National Lab., TN (USA). 9 Feb 1990. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90007374. Available from NTIS, PC A03/MF A01 - OSTI.

The author was invited as one of six lecturers to present a series of lectures on the modern theory of magnetism at the Workshop on Modern Theory of Solids. He attended seminars given by South American scientists and interacted with many participants of the workshop.

20816 (SAND-89-2784) **CCST [Center for Compound Semiconductor Technology] research briefs: Volume 1, Number 2.** Zipperian, T.E.; Voelker, E.R. (eds.). Sandia National Labs., Albuquerque, NM (USA). Dec 1989. 37p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789. Order Number DE90006446. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper discusses the following topics: theoretical predictions of valence and conduction band offsets in III-V semiconductors; reflectance modulation of a semiconductor superlattice optical mirror; magnetoquantum oscillations of the phonon-drag thermoelectric power in quantum wells; correlation between photoluminescence line shape and device performance of p-channel strained-layer materials; control of threading dislocations in heteroepitaxial structures; improved growth of CdTe on GaAs by patterning; role of structure threading dislocations in relaxation of highly strained single-quantum-well structures; InAlAs growth optimization using reflection mass spectrometry; nonvolatile charge storage in III-V heterostructures; optically triggered thyristor switches; InAsSb strained-layer superlattice infrared detectors with high detectivities; resonant periodic gain surface-emitting semiconductor lasers; performance advantages of strained-quantum-well lasers in AlGaAs/InGaAs; optical integrated circuit for phased-array radar antenna control; and deposition and novel device fabrication from $Tl_2Ca_2Ba_2Cu_3O_y$ thin films.

20817 Pulse modulated microwave plasma etching. Grabowski, C. (New Mexico Univ., Albuquerque, NM (USA). Center for High Technology Materials); Gahl, J. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The authors report the etching characteristics of silicon and silicon dioxide studied in an anisotropic microwave plasma etching system having a variably pulsed microwave source. Pulse frequency, as well as pulse duty cycle, can be varied on the microwave source. Earlier work done in isotropic rf systems suggests that etch rate and quality may be affected positively by pulse modulation. Electron-cyclotron resonance heating is used so that the process gas (sulfur hexafluoride) can be more efficiently ionized, with the resulting ions and free radicals from the plasma then etching the silicon substrate or the silicon dioxide on the substrate. Characteristics being examined include etch rate, etch anisotropy, and etching selectivity between silicon and silicon dioxide. The design of the microwave plasma etching system, including the variable pulsed microwave source, are presented along with preliminary results.

20818 Corrosion-related characteristics of plasma ion implanted samples exposed in a steady-state penning discharge. Roth, J.R. (Tennessee Univ., Knoxville, TN (USA). Plasma Science Lab.); Keebler, P.F.; Wu, M.; Buchanan, R.A.; Lee, I.S. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

It has been well established that the implantation of nitrogen ions having energies above 20 keV can have a beneficial effect on the hardness and wear resistance of metals of engineering interest. This paper is a report on the corrosion related characteristics of 304L stainless steel samples which have ben implanted with nitrogen ions having energies above 20 keV, using plasma ion implantation techniques in a steady-state Penning discharge. Plasma ion implantation offers may potential advantages over the wide-used ion beam implantation, including short exposure times (on the order of minutes), isotropic incidence of the ions, and the ability to uniformly implant complex surfaces such as screw threads, gear teeth, and turbine blades.

20819 NMR studies of hydrogen in metals and hydrides at very high temperatures. Barnes, R. (Ames Lab., IA (USA)). *Zeitschrift fuer Physikalische Chemie (Wiesbaden) (Germany, F.R.),* 164(pt.1): 841-851 (1989). DOE Contract W-7405-ENG-82. (CONF-880969–: Metal hydrogen systems fundamentals and applications conference, Stuttgart (Germany, F.R.), 4-9 Sep 1988).

The results of nuclear magnetic resonance (NMR) studies at very high temperatures (up to 1000deg C) on two classes of hydrogen-containing metallic systems - the Group III and IV transition metal dihydrides and the Group III and V metal solid solution phases - are summarized. Anomalous behavior of the nuclear spin-lattice relaxation rate has been found in all these systems at temperatures above $\simeq$ 600 K. Various possible origins of the anomaly are reviewed, and its similarity to behavior found in fast-ion conductors is noted. (orig.).

20820 Proton spin-lattice relaxation rate study of hydrogen motion and cross-relaxation in HCP lutetium. Torgeson, D.R. (Ames Lab., IA (USA)); Han, J.W.; Chang, P.C.T.; Lichty, L.R.; Barnes, R.G. *Zeitschrift fuer Physikalische Chemie (Wiesbaden) (Germany, F.R.),* 164(pt.1): 853-858 (1989). DOE Contract W-7405-ENG-82. (CONF-880969–: Metal hydrogen systems fundamentals and applications conference, Stuttgart (Germany, F.R.), 4-9 Sep 1988).

Proton spin-lattice relaxation rate (R_1) of hydrogen in solid solution in h.c.p. Lu have been measured from 7 to 800 K and 12 to 400 MHz. R_1 arises from conduction electrons, long-range and localized hydrogen motions, and cross-relaxation by the ^{175}Lu nuclear spins. The conduction electron contribution R_{1e} is T/148 s^{-1} for T > 180 K. Evidence of an electronic structure transition was seen at T $\simeq$ 180 K. Long-range hydrogen diffusion yields a hopping frequency $\nu = \nu_0 \exp(-E_a/k_BT)$ with $\nu_0 = 2 \times 10^{13}$ s^{-1} and E_a = 0.52 $\pm$ 0.02 eV/atom. (orig.).

20821 Unique deuteron spin echoes from HD and o-D_2 in large crystal fields. Volz, M.P. (Washington University Department of Physics, St. Louis, Missouri 63130 (USA)); Santos-Filho, P.; Conradi, M.S.; Fedders, P.A.; Norberg, R.E.; Turner, W.; Paul, W. *Physical Review Letters (USA),* 63(23): 2582-2585 (4 Dec 1989).

Novel deuteron multiple spin echoes are observed from HD and o-D_2 molecules trapped in hydrogenated amorphous silicon samples. The echo locations result from the combined action of intramolecular quadrupole and dipole couplings. Using molecular-beam values of the interactions, the observed echo times are predicted to within a few percent. For o-D_2, the echoes demonstrate mixing of l=0 and l=2, m=0 states. The existence of the HD and o-D_2 echoes at low temperatures requires crystal-field admixture of higher J states into the rotational ground state of the molecules.

20822 High-energy beam transport in crystal channels. Newberger, B.S. (Institute for Fusion Studies, The University of Texas at Austin, Austin, Texas 78712 (US)); Tajima, T. *Physical Review [Section] A: General Physics (USA),* 40(12): 6897-6903 (15 Dec 1989).

The transport of high-energy accelerating charged particles in channeling conditions in a crystalline solid is considered by means of a Fokker-Planck model. Multiple scattering on electrons, appropriate to the channeling of positive particles, and radiation damping due to the emission of channeling radiation are also included. Analytic solutions have been obtained for the case of a harmonic channeling potential. Without acceleration, diffusion due to multiple scattering occurs. With acceleration, the adiabatic damping retards this, although the reduction in critical channeling angle with increasing energy eventually competes. For light particles (positrons), the emission of channeling radiation can lead to a steady state. Implications for crystal accelerator schemes are discussed.

20823 Contribution to the quantum-well exciton linewidth due to the intrasubband scattering by optical phonons in an applied electric field. Coffey, D. (Department of Electrical Engineering and Computer Science (C-014), University of California, San Diego, La Jolla, California 92093-0114 (US)— Center for Materials Science (Mail Stop K765), Los Alamos National Laboratory, Los Alamos, New Mexico *Physical Review [Section] B: Condensed Matter (USA),* 40(17): 11654-11658 (15 Dec 1989).

The interaction of excitons with optical phonons is a significant contribution to the linewidth of excitons in quantum wells at room temperature. An electric field, applied in the direction of confinement, polarizes these exciton states, and their interaction with optical phonons is enhanced in polar semiconductors. In this paper, I investigate how this contribution to the linewidth of the electron–heavy-hole exciton changes with applied electric field for different sets of quantum-well parameters where the electron and heavy-hole subbands are taken to be parabolic.

20824 Random-matrix description of the distribution of mesoscopic conductance. Politzer, H.D. (California Institute of Technology, Pasadena, California 91125 (US)). *Physical Review [Section] B: Condensed Matter (USA),* 40(17): 11917-11919 (15 Dec 1989).

Any linear statistic defined on a random-matrix ensemble is shown to be Gaussian distributed. This supports the prediction of weak-disorder perturbation theory in the diffusive, metallic limit for the distribution of conductance, since conductance is a linear statistic on the ensemble of transfer matrices.

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Refer also to citation(s) 19877, 19878, 19892, 19895, 19896, 19900, 19901, 19906, 19907, 19908, 19909, 19910, 19911, 19912, 19913, 19914, 19915, 19916, 19917, 19918, 19919, 19920, 19921, 19922, 19925, 20811, 20816

20825 (BNL–43733) Phase separation of holes in antiferromagnets. Emery, V.J. Brookhaven National Lab., Upton, NY (USA). [1989]. 4p. Sponsored by U.S. DOE Energy Research.

DOE Contract AC02-76CH00016. (CONF-891274–2: Conference on high T_c superconductivity, Los Alamos, NM (USA), 6-9 Dec 1989). Order Number DE90006529. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

It is shown that dilute holes in an antiferromagnet do not have a uniform density but separate into a hole-rich phase and a phase with no holes. The argument is presented for the t–J model but is expected to be more general. When the exchange interaction J exceeds a critical value J_c, one phase consists of all holes, the other all electrons. It is proposed that, for J slightly less than J_c, the hole rich phase is a low density superfluid of electron pairs. 5 refs.

20826 (INIS-SU–153) **Quasi-optical dielectric resonators in investigation of high-temperature superconductors.** Kirichenko, A.Ya.; Cherpak, N.T. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Inst. Radiofiziki i Ehlektroniki. 1988. 28p. (In Russian). Order Number DE90616935. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The paper presents a procedure to investigate the properties of the materials with the high-temperature superconductivity (HTSC) in the electromagnetic fields of superhigh frequencies (SHF). The main concepts of conductivity and superconductor surface impedance are considered in brief outline as well as the methods of measurement of these parameters in SHF fields. The possibilities of using quasi-optical dielectric resonators excited on the higher-type azimuthal oscillations for the measurement of surface impedance of HTSC materials have been studied. The advantages of such resonators which allow to perform the non-destructive test of HTSC samples made in the form of disks from the material of various compound and structure in a wide frequency range and at the mutual orthogonal change of a direction of the SHF field components are shown. It is pointed out that the high reproducibility and reliability of the results are due to the use of the procedure chosen. The examples are give of using the procedure for the determination of SHF characteristics of HTSC ceramics being in normal and superconducting states. 34 refs.; 8 figs.

20827 (KU-HCOE-FL2-R–89-13) **RVB superconductors and tunnel junctions.** Flensberg, K. (Copenhagen Univ. (Denmark). Fysisk Lab.); Hedegard, P. Copenhagen Univ. (Denmark). H.C. Oersted Inst. 1 May 1989. 24p. Order Number DE90616936. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We discuss the consequences of an RVB state modelled with independent charge and spin carriers (holons and spinons, respectively), focusing on the superconducting state. The current-voltage characteristic for a tunnel junction with RVB superconductors on one side of the junction is calculated. We consider different contributions to the current through the junction: quasiparticle current, Andreev current, and Josephson current. We show that the extra degrees of freedom present in the RVB state explain the non-linear quasiparticle characteristics and the low relative Andreev signal. However, in the low voltage regime the independent holon and spinon picture leads to results contradictory to the experimental data: the BCS like structures which are seen experimentally in the spectra are absent. (orig.).

20828 (ORNL/FMP–88/2, pp. 9-241) **ANL-1(A) - Development of nondestructive evaluation methods for structural ceramics.** Ellingson, W.A. (Argonne National Lab., IL (USA)); Roberts, R.A.; Gopalsami, N.; Dieckman, S.; Hentea, T.; Vaitekunas, J.J. Oak Ridge National Lab., TN (USA). Jan 1989. In *Advanced Research and Technology Development fossil energy materials program. Semiannual progress report for the period ending September 30, 1988.* Order Number DE89007896. Available from NTIS, PC A25/MF A01.

This section includes the following papers: Development of Nondestructive Evaluation Methods for Structural Ceramics; Effects of Flaws on the Fracture Behavior of Structural Ceramics; Design, Fabrication, and Interface Characterization of Ceramic Fiber-Ceramic Matrix Composites; Development of Advanced Fiber-Reinforced Ceramics; Modeling of Fibrous Preforms for CVD Infiltration; NDT of Advanced Ceramic Composite Materials; Joining of Silicon Carbide Reinforced Ceramics; Superconducting Film Fabrication Research; Short Fiber Reinforced Structural Ceramics; Structural Reliability and Damage Tolerance of Ceramic Composites for High-Temperature Applications; Fabrication of Ceramic Fiber-Ceramic Matrix Composites by Chemical Vapor Infiltration; Characterization of Fiber-CVD Matrix interfacial Bonds; Microwave Sintering of Superconducting Ceramics; Improved Ceramic Composites Through Controlled Fiber-Matrix Interactions; Evaluation of Candidate Materials for Solid Oxide Fuel Cells; Ceramic Catalyst Materials: Hydrous Metal Oxide Ion-Exchange Supports for Coal Liquefaction; and Investigation of Properties and Performance of Ceramic Composite Components.

20829 Fractional quantization in high-temperature superconductivity. Laughlin, R.B. (Dept. of Physics, Stanford Univ., Stanford, CA (US)). pp. 341 of Mechanisms of high temperature superconductivity. Kamimura, H.; Oshiyama, A Springer-Verlag New York Inc., New York, NY (1989). (CONF-8810437–: Mechanisms of high temperature superconductivity, Hakone (Japan), 24-27 Oct 1988).

In this paper, that the mechanism of high-temperature superconductivity is pairing by a gauge force to occur in the fractional quantum hall problem. This is referred to in 2-dimensional systems as fractional statistics.

20830 Microstructure and in-situ processing of epitaxial high-T_c films. Narayan, J. (North Carolina State Univ., Raleigh, NC (US)); Singh, R.K.; Singh, A.K.; Krishnaswamy, J.; Jagannadham, K.; Lee, C.B.; Prasad, R.K.; Parikh, N.R. pp. 693 of High temperature superconducting compounds: Processing and related properties. The Metallurgical Society Inc., Warrendale, PA (1989). (CONF-8902140–: High temperature superconducting compounds: processing and related properties, Las Vegas, NV (USA), 27-28 Feb 1989).

The authors review the formation of epitaxial and textured (with c-axis perpendicular to the substrate) growth of high-T_c superconducting films on lattice-matched (100)$SrTiO_3$ and lattice-mismatched (100)yttria stabilized zirconia (YSZ) substrates. The texturing process primarily involves grain growth, while thin film epitaxy requires either lattice or planar matching with the substrate. A method based upon positively biasing an interposing ring has been used to achieve stoichiometric deposition and reduce the processing temperature. Atomistic models for important microstructural features including twins, domains, subgrain boundaries in these materials are presented. The emphasis is placed on correlations of the observed microstructures with the superconducting properties.

20831 Recent progress in superconducting $Bi_2Sr_2CaCu_2O_8$ fibers. Gazit, D. (Center for Materials Research, Stanford Univ., Stanford, CA (US)); Peszkin, P.N.; Moulton, L.V.; Brenner, J.M.; Feigelson, R.S. pp. 693 of High temperature superconducting compounds: Processing and related properties. Whang, S.H.; DasGupta, A. The Metallurgical Society Inc., Warrendale, PA (1989). (CONF-8902140–: High temperature superconducting compounds: processing and related properties, Las Vegas, NV (USA), 27-28 Feb 1989).

Recent progress on the growth of $Bi_2Sr_2CaCu_2O_8$ superconducting fibers using the laser heated pedestal method is described. The influence of growth rate on structure and quality was studied. It was found that there exists a threshold growth rate above which the fiber is not single phase but consists of three phases. Annealing fibers in air at 800^0C improved their properties. This was most significant with the fibers grown at high growth rates. A study of the influence of growth atmosphere on fiber properties showed that the best results were obtained in atmospheres containing 20-40% oxygen. A study was also conducted to grow superconductor-metal composites using platinum wire. It was demonstrated that coated wires and edge defined superconducting ribbon could be produced using the laser heated pedestal growth system.

20832 Superconductivity research at the Naval Research Laboratory. Wolf, S.A. (Naval Research Lab., Washington, DC (US)); Osofsky, M.S.; Toth, L.E.; Allen, L.A.; Fuller, W.W.; Claassen, J.H.; LeTourneau, V.; Broussard, P.R.; Elam, W.T.; Qadri, S.B. pp. 693 of High temperature superconducting compounds: Processing and related properties. Whang, S.H.; DasGupta, A. The Metallurgical Society Inc., Warrendale, PA (1989). (CONF-8902140–: High temperature superconducting compounds: processing and related properties, Las Vegas, NV (USA), 27-28 Feb 1989).

The authors are engaged in a program to develop and study the properties of bulk and thin film samples of the high transition temperature superconductors. In addition they have been engaged in a theoretical study of the major parameters both normal and superconducting that can be obtained using two dimensional Fermiology. In this paper, they report the progress made over the past several months in these areas. They have deposited films of YBaCuO on a variety of substrates (MgO, $SrTiO_3$) by coevaporation and have found the critical current density for the best films (deposited on $SrTiO_3$) to be $1x10^6 A/cm^2$ at 4.2K, and $4x10^3$ A/cm^2 at 77K. These films were superconducting below 88K. They discuss a new technique for rapid preparation of thin films which has been successfully been used to prepare several high Tc materials. A new technique for measuring the critical current density in thin films has also been developed which does not require the films to be patterned. This measurement technique is 100 times more sensitive than conventional methods. Regarding bulk superconducting materials, they have discovered a new material, TlSrCaCuO, which is made under conditions of high temperature and pressure. This material enters the superconducting state above 109 K, and completes the transition below 104 K.

6570 Theoretical and Mathematical Physics

Refer also to citation(s) 20624

20833 (CEA-CONF–9530) **Construction of positive (2+1)-dimensional solutions for three discrete Boltzmann models.** Cornille, H. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique Theorique. 1987. 30p. (CONF-8711335–: RCP Meeting Inverse Problems, Montpellier (France), 30 Nov - 4 dec 1987). Order Number DE90752594. Available from NTIS (US Sales Only), PC A03/MF A01.

We study three multidimensional discrete Boltzmann models: the square velocity model, the cubic model with eight velocities oriented towards the eight corners of a cube and the Broadwell model. For two spatial coordinates the two first models, with four independent densities N_i, satisfy the same system of nonlinear equations. The (2+1)-dimensional solutions (time t and two dimensions for the spatial coordinates) are sums of three similarity shock waves solutions. These similarity solutions are rational solutions with one exponential variable. The main difficulty for the construction of these solutions is the positivity condition $N_i > 0$.

20834 (EUR-CEA-FC–1367) **Mode locking and side-bands generation: a mechanism for intermediate stochasticity in conservative systems.** Gell, Y.; Nakach, R. Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. May 1989. 33p. Available from NTIS (US Sales Only), PC A03/MF A01.

We present a numerical study of the two-waves system which reveals the occurrence of stochasticity for a limited range of the perturbation only, beyond which it disappears. We refer to this type of stochasticity as to "Intermediate Stochasticity". Using a Fourier analysis, it is found that intermediate stochasticity is closely associated with the mode locking phenomenon taking place in the system. A theoretical analysis of this phenomenon, based on an extension of the Krylov-Bogoliubov theory of slow variation parameters, appropriate to strongly nonlinear equations, is presented. This analysis explains the main features of the numerical observations.

20835 (GSI–89-84(prepr.)) **Geometrical versus semiclassical quantization.** Caurier, E. (Strasbourg-1 Univ., 67 (France). Centre de Recherches Nucleaires); Drozd, S.; Okolowicz, J.; Ploszajczak, M. Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.). Dec 1989. 13p. Order Number DE90753572. Available from NTIS (US Sales Only), PC A03/MF A01.

The dynamical variational approach based on geometrical quantization is demonstrated to be capable in describing the most important quantum mechanical quantities. In particular, the method appears to be much better under control than the traditional semiclassical methods in treating the systems whose classical counterparts are chaotic. The formal considerations are illustrated using an exactly solvable SU(3)-spin system. (orig.).

20836 (IPNO-TH–88-9) **Static and dynamic variational principles for expectation values of observables.** Balian, R. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique Theorique); Veneroni, M. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique Theorique; Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire. 1988. 71p. (CEA-SPHT–88-28). Order Number DE90752603. Available from NTIS (US Sales Only), PC A04/MF A01.

A general procedure is first reviewed for constructing variational principles (v.p.) suited to the optimization of a quantity of interest. Conditions under which the solution may be obtained as a maximum rather than as a saddle-point are examined. Applications are then worked out, providing v.p. adapted to the evaluation of expectation values, fluctuations or correlations of quantum observables, whether the system is at thermal equilibrium or whether it has evolved. Another class of v.p. concerns dynamical problems. The general method allows to recover a known time-dependent v.p. for a state and an observable [3,13] which answers the following question. Given the state of the system at the time t_0, what is the expectation value $< A >$ at a later time t_1. A more general v.p. applies to situations in which the initial state is too complicated to be handled exactly. Both the approximate initial conditions and the approximate evolution are then determined so as to optimize $< A >$. Finally, analogous v.p. are constructed in classical statistical mechanics and hamiltonian dynamics. A recent formulation of classical mechanics in terms of covariant Poisson brackets [19] comes out naturally in this context from the v.p. for the evaluation of a classical expectation value.

20837 (IPNO-TH–89-08) **Exponential infinite product representations of the time-displacement operator.** Klarsfeld, S.; Oteo, J.A. Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire. Feb 1989. 16p. Order Number DE90752607. Available from NTIS (US Sales Only), PC A03/MF A01.

Fer's infinite product expansion is reconsidered and applied to the specific case of the time-displacement operator in quantum mechanics. An alternative version of this expansion due to Wilcox is also discussed and found to be quite different from the original one. In general the latter is expected to possess better convergence properties.

20838 (LA-UR–89-3575) **Toda lattice with transverse degree of freedom.** Christiansen, P.L. (Los Alamos National Lab., NM (USA)); Lomdahl, P.S.; Muto, V. Los Alamos National Lab., NM (USA). [1989]. 9p. Sponsored by Consiglio Nazionale delle Ricerche; U.S. DOE Management & Administration; Danish Technical Research Council. DOE Contract W-7405-ENG-36. (CONF-8906282–1: 6. interdisciplinary workshop on nonlinear coherent structures in physics, mechanics and biological systems, Montpellier (France), Jun 1989). Order Number DE90002414. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A transverse degree of freedom is introduced in the Toda lattice. The corresponding continuum approximations are discussed. 9 refs.

20839 (ORNL/FTR–3522) **[Method for solving various transport equations]: Foreign trip report, December 30, 1989–January 26, 1990.** Azmy, Y.Y. Oak Ridge National Lab., TN (USA). 31 Jan 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90007375. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler held discussions with members of three research groups: the Mathematical Physics Group of the Italian National Council for Research (CNR), the Mathematics Department at the Politecnico of Torino, and the Nuclear Engineering Laboratory at the University of Bologna. The main theme of these discussions was solution methods for various transport equations, such as nodal methods for the neutron transport equation, and Lie group (similarity) transformations for the non-linear equations of the kinetic theory of rarefied gases. Also modern techniques, such as the discrete model of the Boltzmann equation and its application to problems of

practical interest, were covered. This trip is one in a continuing sequence of exchanges between scientists with common research interests at ORNL and various research institutions in Italy. The travel expenses for this trip were paid by the Italian CNR.

20840 (SAND–89-7153) **Scattering from an arbitrary cylinder in the presence of a planar media interface using the bymoment method.** Lee, R. (Arizona Univ., Tucson, AZ (USA). Electromagnetics Lab.); Cangellaris, A.C. Sandia National Labs., Albuquerque, NM (USA); Arizona Univ., Tucson, AZ (USA). Electromagnetics Lab. Nov 1989. 43p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789. Contract No. 54-1092. Order Number DE90006465. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We apply the bymoment method to the problem of electromagnetic scattering from a cylinder in the presence of two semi-infinite half-spaces. The finite-element method is used to generate the solution over the region occupied by the cylinder, using a grid which is truncated at a small distance from the scatterer by a surface that conforms to the cross-section of the cylinder. We then couple the properties of the region exterior to the finite-element mesh to the interior solution by using Green's theorem in conjunction with a set of linearly independent functions which satisfy the boundary conditions along the interface and at infinity. Numerical results are obtained and compared to those in the literature. 18 refs., 14 figs.

20841 (UCRL–100232) **The extended equivalent source technique with underdetermined sources.** Bevensee, R.M. Lawrence Livermore National Lab., CA (USA). 12 Jan 1989. 3p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-890660–10: Institute of Electrical and Electronics Engineers (IEEE) Antennas Propagation Society (AP-S) international symposium, San Jose, CA (USA), 26-30 Jun 1989). Order Number DE90006989. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Extended Equivalent Source Technique (EEST) is a method of computing electromagnetic scattered fields from discrete equivalent sources which lie some distance away from a surface where a boundary condition is enforced. Possible sources include electric and/or magnetic multipoles and current filaments. Kennaugh extended a spherical multiple solution to nonspherical geometries via a matrix equation. Generally the number K of unknown complex source amplitudes is taken equal to the number I of known complex boundary conditions. However, one can inquire whether there is any advantage to utilizing more unknown sources than there are boundary conditions and solving their amplitudes by a renormalization, maximum likelihood, or maximum entropy procedure. Here we consider a Gibbs' maximum entropy method appropriate for complex data processing if $I < K/2$. 1 fig., 2 refs.

20842 (UWThPh–1988-39) **Physical Holonomy, Thomas Precession, and Clifford Algebra.** Urbantke, H. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 1988. 7p. Order Number DE90616565. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

After a general discussion of the physical significance of holonomy group transformations, a relation between the transports of Fermi-Walker and Levi-Civita in Special Relativity is pointed out. A well-known example -the Thomas-Wigner angle - is rederived in a completely frame-independent manner using Clifford algebra. 14 refs. (Author).

20843 A super-worldsheet approach to the heterotic string. Louis, J. Thesis (Ph. D.). 113p. Univ. of Pennsylvania, Philadelphia, PA (US) (1988). Available from University Microfilms, PO Box 1764, Ann Arbor, MI 48106, Order No.88-24,765.

This thesis contains three main topics. First a superspace formalism of (1,0) supergravity in 2 dimensions is presented. (1,0) supergravity is the worldsheet symmetry of the heterotic string and the action as well as the Virasoro constraints are given in a superfield form. The worldsheet symmetries and the sigma-model symmetries of the action are discussed in detail. In the second part the manifestly supersymmetric formulation is used to calculate superdiffeomorphic, Lorentz and super-Weyl anomalies. The Wess-Zumino consistency condition is formulated in (1,0) superspace and its solution is given. The superspace relation between the superdiffeomorphic and the Lorentz anomaly is discussed in detail. Using similar methods one can also obtain the sigma-model anomalies of the heterotic string. Their relevance to target space physics is emphasized. The use of a superspace formalism resolves the problems of the component approach. In the third part a method, the S-matrix approach, for deriving a low energy effective Lagrangian in 4 dimensions is presented. As an example the Kaehler potential and the superpotential for the scalar fields of toroidal and orbifold compactifications of the heterotic string are given. The effective Lagrangian is derived without going through a field theory limit of the heterotic string, this is the novel feature of the method presented. It includes the exact string tree level result. The moduli space of these compactifications is discussed in detail. It arises from two different viewpoints, from the low energy Lagrangian and from geometrical considerations.

20844 Countable infinity of isospectral potential families. Khare, A. (Institute of Physics, Sachivalaya Marg, Bhubaneswar 751005, (India)); Sukhatme, U.P. *Physical Review [Section] A: General Physics (USA)*, 40(11): 6185-6187 (1 Dec 1989).

Given any one-dimensional potential $V(x)$ with n bound states, we construct an infinite number of isospectral potential families $V^{(a)}(\lambda_0,\lambda_1,\ldots,\lambda_{n-1};x)$. The parameter a takes integer values and the n parameters λ_i take real continuous values. All potentials have identical bound-state eigenvalues, but the reflection and transmission coefficients depend on the index a.

20845 Global coordinates for the breather-kink (antikink) sine-Gordon phase space: An explicit separatrix as a possible source of chaos. Bishop, A.R. (Theoretical Division and Center for Nonlinear Studies, Los Alamos (USA));; McLaughlin, D.W.; Salerno, M. *Physical Review [Section] A: General Physics (USA)*, 40(11): 6463-6469 (1 Dec 1989).

In this paper we present global coordinates for the kink-antikink breather sine-Gordon phase space with a separatrix and singular points. Using these coordinates we derive reduced equations governing perturbed dynamics, and we use them in a Melnikov calculation to establish the presence of chaos in the reduced sine-Gordon system.

20846 Statistical physics of temporal intermittency. Wang, X. (Center for Studies in Statistical Mechanics, University of Texas at Austin, Austin, Texas 78712 (US)). *Physical Review [Section] A: General Physics (USA)*, 40(11): 6647-6661 (1 Dec 1989).

The thermodynamic formalism for dynamical systems is applied to a class of mappings of "laminar-turbulent" temporal intermittency. The corresponding statistical system is shown to be a lattice gas with many-body interactions of clustering type. This one-dimensional system bears a close analogy with the Fisher-Felderhof droplet model of condensation. The abnormal dynamic fluctuations give rise to a phase transition. The critical behaviors, which depend solely on the characteristic exponent z of the original map, are studied analytically, and a number of unexpected results are obtained. In the pressure-temperature plane, the intermittant state is located on a critical line that separates the chaotic ("turbulent") state from the periodic ("laminar") state. The transition from one phase to the other may be of first order if $z<2$. On the other hand, for $2 \leq z$, the "sporadic state" introduced by Gaspard and Wang [Proc. Natl. Acad. Sci. U.S.A. 85, 4591 (1988)] is existent and corresponds to a codimension-two point on the critical curve.

20847 Integration of classical and quantum physics. Tisza, L. (Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139 (US)). *Physical Review [Section] A: General Physics (USA)*, 40(12): 6781-6790 (15 Dec 1989).

The perennial aspect of the Newtonian foundation of mathematical physics is that the concept of "motion," that is, "kinematics," is to serve as the interface between mathematics and physics. Kinematics subdivides into the theory of orbital translation and that of undulation and spinning. Newtonian mechanics is based on giving to translational kinematics a priority over the other modes, since planetary revolution can be represented as translation modified by gravitation. The so-called breakdown of classical physics stems from giving the translational priority a canonical status and extending it to the constituents of matter. We claim that in this case the

priority is to be reversed. The main content of this paper is to establish the algebraic model for an indivisible, undulating entity that we call a "wave simplex." It is used as the point of departure for a non-Newtonian quantum dynamics in which physical and algebraic concepts are in close correspondence. The postulates of the classical phenomenological theories and those of the canonical theories based on translational priority are established as theorems under the proper limiting conditions, and forces are constructed rather than postulated. While the formal structure of two-level quantum mechanics is established as well, exception is taken to treating spin as a property of a point particle. It is considered self-evident that a spinning object is orientable, a property accounted for in terms of a unitary triplet. This is the point of departure for an intrinsic particle dynamics. A main result is the integration of classical and quantum physics, thus closing the gap created by the heuristic method of canonical quantization.

20848 Reply to "Comment on 'Density-matrix formulation of *ab initio* methods of nonrelativistic quantum mechanics' ". Redondo, A. (Electronics Research Group, Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (USA)). *Physical Review [Section] A: General Physics (USA),* 40(11): 6728 (1 Dec 1989).

A missing paragraph from the original work [A. Redondo, Phys. Rev. A 39, 4366 (1989)] that is being commented upon [preceding paper, Cioslowski and Levy, Phys. Rev. A 40, 6727 (1989)] is included. The relationship between this work and a theorem by Lieb [E. Lieb, Phys. Rev. Lett. 46, 457 (1981); 47, 69 (1981)] is also noted.

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Refer also to citation(s) 19704, 20727

20849 (EUR-CEA-FC–1362) **EURATOM-CEA Association Contributions to the 16. European Conference on Controlled Fusion and Plasma Physics.** Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. 1989. 96p. (CONF-890302–: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). Available from NTIS (US Sales Only), PC A05/MF A01.

The contributions to the 16th European Conference on controlled fusion and Plasma Physics are presented. The following subjects, concerning Tore Supra, are discussed: runaway electrons dynamics and confinement; spectroscopic studies of plasma surface interactions; ergodic divertor experiments; magnetic field structure and transport induced by the ergodic divertor; fast ions losses during neutral beam injection; current profile control by electron-cyclotron and lower-hybrid waves; and electromagnetic analysis of the lower hybrid system. The report also includes studies on: a possible explanation for the runaway energy limit (resonant interaction with the ripple field); thermal equilibrium of the edge plasma with an ergodic divertor; neutral confinement in pump limiter with a throat; microtearing turbulence and heat transport; toroidal coupling and frequency spectrum of tearing modes; collisionless fast ion dynamics in tokamaks; variational description of lower hybrid wave propagation and absorption in tokamaks; magnetodrift turbulence and disruptions; specific turbulence associated with sawtooth relaxations in TFR plasmas; detailed structure of the q profile around q = 1 in JET; turbulence propagation during pellet injection; tokamak reactor concept with 100% bootstrap current; optimization of a steady state tokamak driven by lower hybrid waves; and thermodesorption of graphite exposed to a deuterium plasma.

7001 Plasma Research

Refer also to citation(s) 20161, 20162, 20195, 20196, 20605, 20606, 20645, 20817, 20818, 20834, 20984, 20990, 21003, 21011, 21012, 21013, 21016, 21017, 21023, 21024, 21025, 21026, 21027, 21032, 21033, 21034, 21035, 21036, 21037, 21041, 21042, 21045, 21046, 21050, 21051, 21054, 21055, 21056, 21057, 21061, 21062, 21063, 21064, 21066, 21068, 21070, 21072, 21079, 21080, 21081

20850 (DOE/ER/53276–T1) **Colorado School of Mines Fusion Gamma Ray Project: Technical progress report.** Cecil, F.E. Colorado School of Mines, Golden, CO (USA). 5 Jan 1990. 19p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-88ER53276. Order Number DE90007551. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This report summarizes the activities and accomplishments of the CSM Fusion Gamma Ray Project for the calendar year 1989. As reported in last year's Technical Progress Report, the initial objective of the project was the design and bench testing of an eight channel, very high count rate gamma ray spectrometer. The next objective of the project was the installation and field testing of a comparable fifteen channel spectrometer on TFTR. This objective has been accomplished over the past year and the system has been operated successfully at count rates approaching 10 MHz during neutral beam injected (NBI) deuterium plasmas with injected beam powers in excess of 20 MW. The MFE computer network link between CSM and TFTR has been most valuable in the accomplishment of the year's objectives and should serve as a model for future collaborations of outside researchers with experiments on TFTR and CIT. The coming year's work includes the spectrometry of high energy fusion gamma rays during ^{3}He minority ICRH heating of deuterium plasmas and hydrogen minority ICRH heating during Lithium pellet injection as diagnostics of energetic alpha particle production. We include in this report selected results from our parallel grant from the DOE Office of High Energy and Nuclear Physics as they pertain to the present APP grant. These results include experimentally derived thermonuclear reactivities of various light ion fusion plasmas for temperatures up to 40 keV. We would emphasize that our APP project is highly collaborative in nature and that Sid Medley and other members of the TFTR staff deserve much of the credit and bore much of the cost for many of the important accomplishments summarized in this report.

20851 (DOE/ET/53051–148) **University of Wisconsin-Madison plasma physics research (Tokapole II): Final progress report for the period ending October 31, 1986.** Wisconsin Univ., Madison, WI (USA). [1986]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76ET53051. Order Number DE90007379. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This report discusses progress attained on the Tokapole II tokamak in the following areas: gun injection results; stability studies; and shear Alfven resonance heating. (LSP)

20852 (DOE/ET/53088–413) **Thermonuclear instability of global-type shear Alfven modes.** Van Dam, J.W. (Texas Univ., Austin, TX (USA). Inst. for Fusion Studies); Fu, G.Y.; Cheng, C.Z. Texas Univ., Austin, TX (USA). Inst. for Fusion Studies. Jan 1990. 39p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-80ET53088;AC02-76CH03073. (IFSR–413). Order Number DE90007087. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The effects of thermonuclear alpha particles on the stability of global-type shear Alfven waves in toroidal geometry in an ignition tokamak experiment are described. The presence of finite toroidicity can lead to stabilization of the so-called global shear Alfven eigenmode. However, toroidicity induces a new global shear Alfven eigenmode, which can be strongly destabilized via transit resonance with alpha particles. In the proposed International Thermonuclear Experimental Reactor, due to its large size and low density, this latter mode is found to be benign. 17 refs., 10 figs.

20853 (DOE/ET/53088–415) **Enhanced pinch effect due to electrostatic potential.** Shaing, K.C. (Oak Ridge National Lab., TN (USA)); Hazeltine, R.D. Texas Univ., Austin, TX (USA). Inst. for Fusion Studies. Jan 1990. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-80ET53088. (IFSR–415). Order Number DE90007088. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

An inward pinch appears necessary to explain experimental results in tokamaks. Neither the neoclassical pinch effect, which is too small, nor the off-diagonal quasilinear term, which is usually outward in the trapped particle regime, can account for the observations. A mechanism for an enhanced inward pinch is proposed, based on results for an asymmetric magnetic field bump. Because

turbulent fluctuations also break toroidal symmetry, an enhanced inward pinch driven by the fluctuations and the Ohmic inductive field, E is expected. To demonstrate this effect, an inward particle flux is calculated for a model tokamak configuration that has an electrostatic potential bump Φ_0 at toroidal angle $\zeta = 2\pi$. For the parameter regime $r/R < e\Phi_0/T_e < 1$, the flux is found to be $\Gamma = -4.47K\ (q)\ (r/R)\ L(\Phi_0)(\upsilon_{te}/R\nu e)^{1/2}cN\ E/B$, where r(R) is minor (major) radius, B is the magnetic field strength, υ_{te} is the electron thermal speed, ν_e is the electron-ion collision frequency, q is the safety factor, and K(q) and L(Φ_0) are functions of q and Φ_0 respectively. The results are also applicable to an asymmetric potential bump created externally to enhance the inward pinch flux of high energy, collisionless particles. 11 refs., 1 fig.

20854 (EUR-CEA-FC–1362, pp. 1-4) **Runaway electrons dynamics and confinement in Tore-Supra.** Chatelier, M. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 -Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee); Geraud, A.; Joyer, P.; Martin, G.; Rax, J.M. Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. 1989. (CONF-890302–: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *EURATOM-CEA Association Contributions to the 16. European Conference on Controlled Fusion and Plasma Physics.* Order Number DE90752562. Available from NTIS (US Sales Only), PC A05/MF A01.

The lack of energy of runaway electrons, confined in Tore Supra tokamak, is studied. Ohmic discharges, obtained with helium gas, exhibit a small amount of runaway electrons on both hard X-ray monitors and neutron sensors. The observations show an important lack of energy for runaway electrons confined in Tore Supra. It is assumed to be dued to a small pitch-angle scattering (a few degrees), and many candidates for this are compared: the strongest known one collisions seems not to be enough by an order of magnitude. Density and magnetic scans on Tore Supra are needed to discriminate between enhanced collisional scattering processes and purely magnetic phenomena.

20855 (EUR-CEA-FC–1362, pp. 5-8) **Spectroscopic studies of plasma surface interactions in Tore Supra.** Klepper, C.C. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 -Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee); Hess, W.R.; Fall, T.; Hogan, J.T.; Achard, M.E.; Grosman, A.; Guilhem, D. Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. 1989. (CONF-890302–: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *EURATOM-CEA Association Contributions to the 16. European Conference on Controlled Fusion and Plasma Physics.* Order Number DE90752562. Available from NTIS (US Sales Only), PC A05/MF A01.

The discharges taking place during the early phase of Tore Supra operation are studied. The experimental set up is composed of: a 0.64 m Czerny-Turner spectrometer equipped with an optical multichannel analyzer and a grating with 2400 gr/mm is used. The spectral range available extends from 300 to 800 nm. Each fiber views a chord through the plasma of about 6 cm in width. Nine radial views are achieved. They scan the bottom half of the poloidal cross-section. The electron temperature is assumed to be the half of the ionization potential of the considered ion. For the first Tore Supra discharges only one line of sight is available. The spatial distributions are modeled by a 3D neutral transport code which is coupled to a 2D equilibrium code. The measured local ionization sources and their ratios to the modeled poloidally weighted sources are given. In the computation of Tp the absence of the HeII contribution to the source is overcome with the approximation that 2 electrons are contributing for each He atom. Using only the neutrals, a total ionization source of $1.6*10^{21}$ particles/s is found and a particle confinement time of 127ms is computed.

20856 (EUR-CEA-FC–1362, pp. 9-12) **Ergodic divertor experiments on Tore Supra.** Evans, T.E. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 -Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee); Grosman, A.; Capes, H.; Samain, A.; Ghendrih, P. Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. 1989. (CONF-890302–: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *EURATOM-CEA Association Contributions to the 16. European Conference on Controlled Fusion and Plasma Physics.* Order Number DE90752562. Available from NTIS (US Sales Only), PC A05/MF A01.

The Tore Supra ergodic divertor program concerning investigations on particle confinement and impurity control experiments, during a first series of experiments, is discussed. The experimental hardware is described. Numerical and analytical models are shown. The dynamics and the production of impurities with an ergodic divertor are considered. The hypothesis that a cold, high density layer, forming near the wall, will radiate strongly and cool the outflowing plasma particles before they hit the facing components, is planned to be examined. The drag effect, important for sweeping impurities out of the discharge, is included. The program analysis leads to the conclusion that experimental data must be acquired and the basic models tested, before to reach a physical understanding of impurity transport and production with an ergodic layer.

20857 (EUR-CEA-FC–1362, pp. 13-16) **Magnetic field structure and transport induced by the ergodic divertor of Tore Supra.** Samain, A. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee); Ghendrih, P.; Grosman, A.; Capes, H.; Evans, T.; Morera, J.P. Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. 1989. (CONF-890302–: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *EURATOM-CEA Association Contributions to the 16. European Conference on Controlled Fusion and Plasma Physics.* Order Number DE90752562. Available from NTIS (US Sales Only), PC A05/MF A01.

The quasilinear analysis of transport in stochastic fields (including the electric perturbation), which is to be tested by the ergodic divertor experiments on Tore Supra, is discussed. On Tore Supra configuration, the magnetic connection is due to a resonant magnetic perturbation, which creates a stochastic layer between the hot plasma and the wall. The coils, creating the magnetic perturbation, consist in 6 identical modules 60 degrees apart, in the toroidal direction. A radial perturbation of the magnetic field allows a radial transport of energy through the parallel motion of the electrons. Concerning plasma connection, it is shown that the ergodic layer can maintain a constant pressure profile.

20858 (EUR-CEA-FC–1362, pp. 17-20) **Thermal equilibrium of the edge plasma with an ergodic divertor.** Capes, H. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee); Ghendrih, P.; Samain, A.; Grosman, A.; Morera, J.P. Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. 1989. (CONF-890302–: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *EURATOM-CEA Association Contributions to the 16. European Conference on Controlled Fusion and Plasma Physics.* Order Number DE90752562. Available from NTIS (US Sales Only), PC A05/MF A01.

An ergodic divertor layer in the presence of radiating impurities, is studied. The expected effect of the divertor is to build up a layer with a constant radial pressure profile. The electron density is assumed to be sufficiently high so that the thickness of the neutral layer can be neglected. The number of steady equilibria is discussed in terms of the incident power, impurity species and concentrations. The possibility of bifurcation between equilibrium states is discussed (S shaped diagrams). In the case of radiation in the coronal limit, it is shown that the standard situation exhibits only one steady state. The results lead to the conclusion that a strong impurity concentration is required for bifurcation to appear when the energy flux is varied. The importance of the gamma-1 value,

imposed by the sheath physic, is confirmed. With lower gamma-1 value, lower impurity concentration is necessary. The heat equation admits only one equilibrium state. The thermal stability of the layer, except in cases of oscillating modes, is insured.

20859 (EUR-CEA-FC–1362, pp. 25-28) **Fast ions losses during neutral beam injection in Tore-Supra.** Grua, P. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 -Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee); Roubin, J.P. Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. 1989. (CONF-890302–: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *EURATOM-CEA Association Contributions to the 16. European Conference on Controlled Fusion and Plasma Physics.* Order Number DE90752562. Available from NTIS (US Sales Only), PC A05/MF A01.

The Fokker-Planck calculation of the fast ions losses occurring during neutral beam injection (NBI), in Tore Supra tokamak, are presented. The sensitivity of these losses to various plasma parameters are tested and the most favourable heating scenarios are indicated. The Tore Supra NBI system is planned to provide a total power capability of 9 MW. The minimization of the ion losses is investigated. The effect of the plasma density and the displacements of the plasma column inside the vacuum vessel, are considered. The Fokker-PLanck calculations predict fast ions losses during NBI in Tore Supra. These losses are mainly due to beam ions on banana orbits with tips in the effective ripple zone. It is shown that the plasma position inside the vacuum vessel as well as density (average and profile) are sensible parameters. For smaller, inner wall limited plasmas (a=70cm) and for peaked density profiles, losses can be reduced to smaller values (25%). A vertical displacement of the plasma column in the opposite direction of the ion drift velocity can also improve fast ion confinement.

20860 (EUR-CEA-FC–1362, pp. 29-32) **Microtearing turbulence and heat transport.** Garbet, X. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee); Mourgues, F.; Samain, A. Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. 1989. (CONF-890302–: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *EURATOM-CEA Association Contributions to the 16. European Conference on Controlled Fusion and Plasma Physics.* Order Number DE90752562. Available from NTIS (US Sales Only), PC A05/MF A01.

The microtearing modes and the heat transport in tokamaks are discussed. A model, in which the non linear action of modes (on a given Fourier component of the perturbed distribution function) is represented by a velocity dependent diffusion coefficient operator, is applied. The aim of the study is a better understanding of the process (in collisionless regimes) in which microtearing modes are driven unstable. The results show that it can be obtained under the effect of the radial diffusion they induce in non linear regimes where magnetic islands overlap. Moreover, the bounds obtained on the heat transport coefficient do not allow to neglect such a turbulence.

20861 (EUR-CEA-FC–1362, pp. 33-36) **Toroidal coupling and frequency spectrum of tearing modes.** Edery, D. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee); Samain, A.; Pecquet, A.L.; Vallet, J.C.; Lecoustey, P. Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. 1989. (CONF-890302–: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *EURATOM-CEA Association Contributions to the 16. European Conference on Controlled Fusion and Plasma Physics.* Order Number DE90752562. Available from NTIS (US Sales Only), PC A05/MF A01.

A model on the magnetohydrodynamic activity, in tokamak devices, is proposed. The analysis of the observed poloidal structures, the growth rates and frequencies of the modes, are included. The considered magnetic perturbation is derived from a potential vector parallel to the undisturbed toroidal field. The toroidal coupling, the resonant currents, the inner and outer solutions are discussed. The proposed model provides the relative amplitude $Psi_m(r_m)$, from which the external mode structure may be deduced and compared to the magnetic probe data. It also provides the structure of the pumped internal m=1 n=1 mode by its neighbouring m=2 n=1, which may be compared with the soft X-ray data analysis. It is possible to explain the mode frequency R_e(omega) in terms of diamagnetism and plasma rotation at the resonant layers.

20862 (EUR-CEA-FC–1362, pp. 37-40) **Collisionless fast ions dynamics in tokamaks.** Becoulet, A. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee); Gambier, D.J.; Grua, P.; Rax, J.M.; Roubin, J.P. Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. 1989. (CONF-890302–: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *EURATOM-CEA Association Contributions to the 16. European Conference on Controlled Fusion and Plasma Physics.* Order Number DE90752562. Available from NTIS (US Sales Only), PC A05/MF A01.

Two situations, in which collisionless processes dominates the dynamics of fast ions population, in Tokamak devices, are investigated. The heating of energetic ions under the effect of a compressional wave, and alpha particle losses induced by the toroidal field ripple, are considered. The hamiltonian description of collisionless transport shows that the stochastic behaviour legitimates the random phase approximation and the quasi-linear theory, even for very energetic ions. Moreover, diffusion coefficients are derived and Poincare maps for alpha particles are presented. Concerning the toroidal field ripple, it is shown that this perturbation dominates the trapped alpha particles transport as soon as delta approx 10^{-3}.

20863 (EUR-CEA-FC–1362, pp. 41-44) **Variational description of lower hybrid wave propagation and absorption in tokamaks.** Moreau, D. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 -Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee); Peysson, Y.; Rax, J.M.; Samain, A.; Dumas, J.C. Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. 1989. (CONF-890302–: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *EURATOM-CEA Association Contributions to the 16. European Conference on Controlled Fusion and Plasma Physics.* Order Number DE90752562. Available from NTIS (US Sales Only), PC A05/MF A01.

A variational approach to a global solution of the lower-hybrid wave propagation and absorption in tokamaks is presented. It is based on the use of trial functions which are locally solutions of the homogeneous problem ("eikonal trial functions"). Preliminary results in circular cylindrical geometry are reported, showing the radial power deposition profiles for various toroidal wavenumbers excited by the r.f. source.

20864 (EUR-CEA-FC–1362, pp. 45-48) **Current profile control by electron-cyclotron and lower-hybrid waves in Tore Supra.** Giruzzi, G. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 -Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee); Fidone, I. Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. 1989. (CONF-890302–: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *EURATOM-CEA Association Contributions to the 16. European Conference on Controlled Fusion and Plasma Physics.* Order Number DE90752562. Available from NTIS (US Sales Only), PC A05/MF A01.

A theoretical study on the current drive process by means of simultaneous injection of electron-cyclotron (EC) and lower-hybrid (LH) waves, in Tore Supra, is presented. The considered top launching EC waves frequency is F= 110 GHz. The EC wave

damping is computed by means of a toroidal ray-tracing code, incorporating the evaluation of the relativistic dielectric tensor for an arbitrary electron distribution. The LH-driven electron tail is determined by means of a 3D bounce-averaged Fokker-Planck code. The evolution of the electron distribution function during the absorption of high power EC waves, is also evaluated. It is shown how the LH-sustained electron system can be used to simulate, in a low temperature plasma, the Maxwellian tail of a hot plasma. This allows the investigation of EC current drive in conditions similar to those in the reactor regime. The radial profiles of the current, driven by the LH waves and by the ECLH system are given.

20865 (EUR-CEA-FC–1362, pp. 49-52) **Electromagnetic analysis of the lower hybrid system of Tore Supra.** Goniche, M. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 -Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee); Bibet, P.; Moreau, D.; Rey, G.; Tonon, G. Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. 1989. (CONF-890302–: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *EURATOM-CEA Association Contributions to the 16. European Conference on Controlled Fusion and Plasma Physics.* Order Number DE90752562. Available from NTIS (US Sales Only), PC A05/MF A01.

The power division, in amplitude and phase, of the two Tore Supra lower hybrid antennas, is investigated. The system is composed by 120 power dividers and 128 waveguides facing the plasma. The main features of the antennas are given. The block diagram of the computing procedure is presented. Due to the low coefficient of reflection of the multijunctions, only one interaction is needed to obtain the exact power division. It is found that the inner rows of waveguides, with L1=180 degrees, have lower directivity for negative phasing than for positive phasing of the modules. It is found that: 2 rows of 32 waveguides, using the same type of multijunctions, excite similar N spectrum; and 2 rows with different types of multijunctions have different directivity. Due to the symmetry of the system, reflected fields recombining in the hybrid junction are close in phase and in amplitude. The coefficients of reflection toward the klystrons are approx 0.1%.

20866 (EUR-CEA-FC–1362, pp. 53-56) **Magnetodrift turbulence and disruptions.** Andreoletti, J. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 -Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee). Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. 1989. (CONF-890302–: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *EURATOM-CEA Association Contributions to the 16. European Conference on Controlled Fusion and Plasma Physics.* Order Number DE90752562. Available from NTIS (US Sales Only), PC A05/MF A01.

The minor and major disruptions of a sawtooth relaxation model, in tokamaks, are discussed. In the proposed model, magnetodrift (md) motions exist only in configurations having, along B lines, a large scale asymmetry of the local magnetic shear. Concerning the magnetic relaxation, the md turbulence produces a fast transport, that results in a tendency of J/B to become constant in the turbulent domain. In the sawtooth disruption model, the md turbulence triggers a fast transition from resistive kink to quasi-mhd kink. Experimental results are in agreement with the proposed md turbulence, in TFR plasmas. The poloidal rotation and the helical current perturbation effects are considered. Concerning minor disruptions, the plasma evolves to this situation either by an increase of density or current. Moreover, transport of electron energy and current relaxation produce an evolution of the magnetic structure. Major disruption can take place, when the external mhd kink becomes unstable. Other possibility to major disruption can be given by any process generating an enlarged and steepened current density profile.

20867 (EUR-CEA-FC–1362, pp. 57-60) **Specific turbulence associated with sawtooth relaxations in TFR plasmas.** Andreoletti, J. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 -Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee); Laviron, C.; Olivain, J.; Gervais, F.; Gresillon, D.; Hennequin, P.; Quemeneur, A.; Truc, Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. 1989. (CONF-890302–: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *EURATOM-CEA Association Contributions to the 16. European Conference on Controlled Fusion and Plasma Physics.* Order Number DE90752562. Available from NTIS (US Sales Only), PC A05/MF A01.

The specific turbulence during the sawtooth relaxation which superimposes the quasi-stationary (QS) turbulence, is investigated. Experimentally it corresponds to burts of fluctuations observed on the high frequency side of the QS spectrum. A CO2 coherent scattering diagnostic is used to perform the experiments. The scattering volume consists on a vertical chord which is radially scanned. The experiments, performed on TFR tokamak, concern k = 5 or 7/cm. The analysis of the temporal amplitude variation allows to define three stages in the turbulent process. Each stage typically lasts 20mus. The azimutal and the radial localizations are studied. It is concluded that the turbulence is azimutally localized on the cold side. Concerning the numerical model, a spatial level model decaying in both the r and theta directions (with gaussian profiles), is adapted. The azimutal direction in which the heat flux appears is defined by means of the soft X-rays signals. It is shown that the lifetime of the cell of turbulence (localized in the interior of the q=1 surface with an azimutal full width extension of about 120 degrees) coincides with the collapse of the sawtooth. These observations are in agreement with the so called "magnetodrift" turbulence in the sawtooth disruption model.

20868 (EUR-CEA-FC–1362, pp. 61-64) **Detailed structure of the q profile around q=1 in JET.** Pegourie, B. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 -Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee); Dubois, M.A.; Gill, R.D. Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. 1989. (CONF-890302–: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *EURATOM-CEA Association Contributions to the 16. European Conference on Controlled Fusion and Plasma Physics.* Order Number DE90752562. Available from NTIS (US Sales Only), PC A05/MF A01.

The analysis of the pellet ablation in the q=1 region of JET tokamak is presented. The radial heat and matter transports, and the density structure of the neutral cloud effects are neglected. It is shown that an extended shearless zone around q=1 is necessary to reproduce the experimental signal. Moreover, it must be taken into account in any theory of internal disruption. An accurate analysis of the shoulder on the q profile, which appears several times in the sawtooth period, is suggested.

20869 (EUR-CEA-FC–1362, pp. 65-68) **Turbulence propagation during pellet injection.** Garbet, X. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee); Laurent, L.; Mourgues, F.; Roubin, J.P.; Samain, A. Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. 1989. (CONF-890302–: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *EURATOM-CEA Association Contributions to the 16. European Conference on Controlled Fusion and Plasma Physics.* Order Number DE90752562. Available from NTIS (US Sales Only), PC A05/MF A01.

It has been observed in the TFR tokamak that an injected pellet was preceded by a cold front propagating at about twice its velocity. The aim of this paper is to show that the observed phenomena can be interpreted as a manifestation of the ballooning structure of modes destabilised by the pellet.

20870 (EUR-CEA-FC–1362, pp. 69-72) **Tokamak reactor concept with 100% bootstrap current.** Ane, J.M. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 -

Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee); Laurent, L.; Samain, A. Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. 1989. (CONF-890302--: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *EURATOM-CEA Association Contributions to the 16. European Conference on Controlled Fusion and Plasma Physics.* Order Number DE90752562. Available from NTIS (US Sales Only), PC A05/MF A01.

The concept of a tokamak reactor with 100% bootstrap current, using pellet injection and dynamo effect, is investigated. The current is obtained by monitoring the electron temperature and density profiles. The ways to obtain these profiles in a thermonuclear reactor are suggested. The relaxation of the current profile and the compatibility with a thermonuclear reactor are analyzed. The viability of the model is shown to depend: on a low particle and heat transport in the plasma center; and of the possibility that plasma current relax repeatedly around a state of flat q=1 profile in the central region. Predictions concerning these two points are difficult to be made since they are not fully understood in existing plasmas.

20871 (EUR-CEA-FC–1362, pp. 73-76) **Optimization of a steady state tokamak driven by lower hybrid waves.** Tonon, G. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee). Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. 1989. (CONF-890302--: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *EURATOM-CEA Association Contributions to the 16. European Conference on Controlled Fusion and Plasma Physics.* Order Number DE90752562. Available from NTIS (US Sales Only), PC A05/MF A01.

The feasibility of the tokamak steady state obtention, applying lower hybrid waves is investigated. A NET/ITER - like device is considered, and the increase of the reactor reliability and availability is taken into account. The main characteristics of the rf system (frequency f > 4.5 GHz) are obtained. The wave penetration in the plasma core and the current merit factor eta maximization are ensured. An analytical expression of eta is given. It seems possible in ITER, using LHW alone, to reach Q approx 8, the neutron wall loading approx 0.7 MW/m^2, if a moderate value enhancement factor H approx 1.2 is achieved.

20872 (EUR-CEA-FC–1362, pp. 81-84) **First lower hybrid current drive experiments at 3.7 GHz in Tore Supra.** Tonon, G. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee (France)); Goniche, M.; Moreau, D. Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. 1989. (CONF-890302--: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *EURATOM-CEA Association Contributions to the 16. European Conference on Controlled Fusion and Plasma Physics.* Order Number DE90752562. Available from NTIS (US Sales Only), PC A05/MF A01.

The results of electromagnetic waves injection in the Tore Supra plasma, at a frequency of 3.7 GHz, are reported. The process is applied for current generation and plasma heating, through Landau damping on the electron population. The experimental set-up is described. The lower hybrid current drive experiments in Tore Supra are carried out under the following conditions: major and minor radii of the plasma are respectively 2.37 m and 0.77 m and the toroidal magnetic field is 1.8 Teslas. A multijunction-grill composed of 128 waveguides is applied. Up to 1.25 MW of rf power is injected in Tore Supra, after less than 30 plasma shots. The results lead to the conclusion that the coupling, not yet optimized, is good enough for safe klystron operation with no circulator. The measured value Rlp P_{RF}^{-1} (deltaV$_L$/V$_L$) obtained on Tore Supra (Bt = 1.8 T) is closed to one observed on PETULA-B (Bt = 2.75 T) at the same frequency and density.

20873 (EUR-CEA-FC–1362, pp. 85-88) **First pump limiter experiments in Tore Supra.** Chatelier, M. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee); Bruneau, J.L.; Chappuis, P.; Gil, C.; Guilhem, D.; Lipa, M.; Rodriguez, L.; Vallet, J.C.; VAssociation Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. 1989. (CONF-890302--: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *EURATOM-CEA Association Contributions to the 16. European Conference on Controlled Fusion and Plasma Physics.* Order Number DE90752562. Available from NTIS (US Sales Only), PC A05/MF A01.

The thermal load and the particle pumping effects on the outboard pump limiters (OPL), in Tore Supra are analyzed. The investigations are performed for the plasma either in contact with the OPL/ONPL (outboard non pumped limiters) alone or with the OPL and the vertical limiters together. Calorimetric measurements provide estimates of the time-integrated balance of the energy flow at the plasma edge. Radiated and charge exchange energy losses are deduced from the inner vessel calorimetry (R=242cm, a=94cm). Conductive/convective losses on the OPL and vertical (top and bottom) limiters are independently measured, as well as the integrated energy flow on the ergodic divertors. The calorimetric results, the bolometric measurements of the radiated power and the Ohmic power estimates, are indicated. The central line density from interferometric measurement for the two successive shots, with the ONPL and with the OPL, are given.

20874 (EUR-CEA-FC–1362, pp. 89-92) **Edge plasma modification induced by a resonant perturbation during ergodic divertor experiments on Tore Supra.** Grosman, A. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee); Samain, A.; Ghendrih, P.; Evans, T.E. Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. 1989. (CONF-890302--: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *EURATOM-CEA Association Contributions to the 16. European Conference on Controlled Fusion and Plasma Physics.* Order Number DE90752562. Available from NTIS (US Sales Only), PC A05/MF A01.

The ergodic divertor (ED) experiments on the Tore Supra tokamak, are reported. The experimental conditions are the following: the toroidal field B_{phi}approx 1.8T, the plasma current I_p approx 0.5 to 1.2 MA, the line average density n_e approx 2. to 3.10^{19} m^{-3}, with helium gas. Two configurations are considered: the "EXT" configuration, where the plasma is limited by an outer passive limiter in the mid plane 0.04 m ahead of the ED coils; and the "INT" configuration, where the plasma is limited on the inner wall (axisymmetric limiter). The experiments show the expected resonant effect induced by the magnetic perturbation. No degradation of the bulk of the discharge is observed. The features of the ergodic divertor discharges are a modification of recycling, a broadening of the scrape-off layer, a modification of the edge plasma and in some cases a possbile improvement in the bulk plasma.

20875 (EUR-CEA-FC–1362, pp. 93-96) **Soft X-ray spectroscopy during Tore Supra ergodic divertor experiments.** Monier, P. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee); Breton, C.; DeMichelis, C.; Mattioli, M.; Ramette, J.; Saoutic, B. Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. 1989. (CONF-890302--: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *EURATOM-CEA Association Contributions to the 16. European Conference on Controlled Fusion and Plasma Physics.* Order Number DE90752562. Available from NTIS (US Sales Only), PC A05/MF A01.

The soft X-ray impurity emission during ergodic divertor experiments, in Tore Supra tokamak, are studied. The experiments are

performed with an extreme grazing incidence spectrograph. A powerful radial scan system, allowing the radial emissivity profiles of several soft X-ray lines to be recorded within a single discharge, is applied. The radial emissivity profiles of five light impurity lines are studied as a function of the magnetic perturbation introduced by the ergodic divertor. Perturbation effects on the radial position of the emissivity shells can be interpreted in terms of electron temperature gradient or transport modifications. The expected resonant effect is clearly detected. The system of radial scan associated to the Schwob-Fraenkel spectrograph is successfully operated. The available experimental data do not allow to choose between impurity transport and electron temperature gradient changes at the plasma edge as the cause of impurity ion emissivity profile modifications.

20876 (EUR-CEA-FC–1362, pp. 4 Bis) **A possible explanation for the runaway energy limit: resonant interaction with the ripple field.** Laurent, L. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 -Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee); Rax, J.M. Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. 1989. (CONF-890302–: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *EURATOM-CEA Association Contributions to the 16. European Conference on Controlled Fusion and Plasma Physics.* Order Number DE90752562. Available from NTIS (US Sales Only), PC A05/MF A01.

The resonant interaction between the runaway particle population and the ripple field is investigated. It is shown that the k =2 component is the leading term. Moreover, the electron behaviour is driven by three effects; the loop voltage acceleration, the previous diffusion and the cyclotron radiative cooling (approximately at constant pitch angle). When the diffusion coefficient is large the electrons can not reach energy larger than the resonant one. The model explains the energy limitation in Tore Supra. The limitation is expected to disappear in the high field operating regime: the synchrotron limit appears before the resonance.

20877 (EUR-CEA-FC–1368) **Collisional conversion between Landau absorption and synchrotron radiation.** Rax, J.M. Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. May 1989. 21p. Contract JJ6/9012. Available from NTIS (US Sales Only), PC A03/MF A01.

The non-thermal synchrotron emission induced by quasi-linear Landau absorption of lower-hybrid waves is investigated. This process can be viewed as a collisional power conversion, via pitch angle scattering, from the absorbed lower hybrid power to the radiated synchrotron power. The conversion ratio is calculated and influence of the various parameters discussed.

20878 (EUR-CEA-FC–1369) **Non-local responses in wave driven tokamaks.** Rax, J.M.; Moreau, D. Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. May 1989. 21p. Contract JJ6/9012. Available from NTIS (US Sales Only), PC A03/MF A01.

The current response induced by suprathermal Landau absorption, in a tokamak plasma, is shown to be non-local. The integral kernel describing this effect which stems from the coupling between space and velocity diffusions is calculated. Consequences on the wave driven current profiles and the global current drive efficiency are presented.

20879 (EUR-CEA-FC–1370) **Thermal equilibrium in a diverted plasma.** Capes, H.; Ghendrih, P.; Samain, A.; Grosman, A.; Morera, J.P. Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. May 1989. 19p. Available from NTIS (US Sales Only), PC A03/MF A01.

The number of steady solutions of the heat equation is determined for given control parameters in axisymmetric or ergodic divertors. Several impurity species are used (C,O,Fe) with coronal or non coronal assumptions. We show that the number of equilibria strongly depends on the radiation emission and on the boundary conditions at the wall. A strong concentration of light impurity is needed for several thermal equilibria to exist and bifurcation to be possible.

20880 (EUR-CEA-FC–1371) **Toroidal coupling and frequency spectrum of tearing modes.** Edery, D.; Samain, A. Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. May 1989. 15p. Available from NTIS (US Sales Only), PC A03/MF A01.

The frequency spectrum of tearing modes is analyzed with the help of a mode coupling model including toroidal effects in the MHD regions and various non linear effects in the resonant layers. In particular it is shown that the sudden damping of the mode rotation and the simultaneous enhancement of the growth rate observed in tokamak, could be explained as a bifurcating solution of the dispersion equation.

20881 (IAEA-TECDOC–534) **Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.** International Atomic Energy Agency, Vienna (Austria). Dec 1989. 319p. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

The proceedings of a technical committee meeting on pellet injection and toroidal confinement, held in Gut Ising, Federal Republic of Germany, 24-26 October, 1988, are given in this report. Most of the major fusion experiments are using pellet injectors; these were reported at this meeting. Studies of confinement, which is favorably affected, impurity transport, radiative energy losses, and affects on the ion temperature gradient instability were given. Studies of pellet ablation and effects on plasma profiles were presented. Finally, several papers described present and proposed injection guns. Refs, figs and tabs.

20882 (IAEA-TECDOC–534, pp. 27-34) **Results of pellet injection experiments in JT-60.** JT-60 Team. International Atomic Energy Agency, Vienna (Austria); Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment. Dec 1989. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.* Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

This paper presents recent experimental results of pellet injection to joule plasmas and heating experiments of pellet injected plasmas by NB, LHRF, and ICRF. Especially clear improvement in confinement has been obtained in NB heating of pellet injected plasma up to 10-15MW in Ip=1.5-1.8MA lower-side X-point divertor configuration. (author). 4 refs, 8 figs.

20883 (IAEA-TECDOC–534, pp. 35-41) **Improved plasma performance by repetitive pellet injection in ASDEX.** Mertens, V. (Association Euratom-Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)); Kaufmann, M.; Lang, R. ASDEX Team; NBI Team; ICRH Team. International Atomic Energy Agency, Vienna (Austria). Dec 1989. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.* Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

Experiments with repetitive pellet injection were performed in ASDEX divertor discharges under purely Ohmic as well as with NBI and ICRH heating. The pellets used were of two different sizes each contributing 1 or $3x10^{19}cm^{-3}$, respectively, to the volume averaged plasma density. The parameter scans concentrated on discharges with B_t = 2.2 T, I_p = 380 kA, and covered a line-averaged electron density range between $\bar{n}_e$ = $1.4x10^{20}m^{-3}$ (2.6 MW NBI). Both latter values constitute increases by approximately $\bar{n}_e$ = $5.5x10^{19}m^{-3}$ over the respective limits in gas-puff discharges and correspond to Murakami parameters of $\bar{n}_eR/B_t$

= $8x10^{19}m^{-2}T^{-1}$ and $10.5x10^{19}m^{-2}T^{-1}$. Additional heating powers applied so far to these discharges ranged up to 2.6 MW of NBI and 1.3 MW of ICRH. Pellet injection is found to give rise to density peaking also inside the deposition radius of the pellet particles. It leads to a long lasting increase of $n_e(0)/<n_e>_{vol}$ from 1.5 to 2.6 which can be explained only by an increase in the ratio of the inward pinch velocity to the particle diffusion coefficient - V/D. In Ohmic deuterium discharges, this increase is typically a factor of 1.5. In addition the diffusive mixing process caused by sawteeth is normally reduced and sometimes eliminated by pellet injection. With additional heating the global peaking parameter $n_e(0)/<n_e>_{vol}$ is gradually reduced. Additionally to the transport on the typical diffusive timescale a fast inward transport of particles on a timescale of <2ms is sometimes observed immediately following the pellet deposition. (author). 4 refs, 6 figs.

20884 (IAEA-TECDOC–534, pp. 43-50) **JET multi-pellet injection experiments.** Kupschus, P. (Commission of the European Communities, Abingdon (UK). JET Joint Undertaking); Bartlett, D.V.; Baylor, L.R. International Atomic Energy Agency, Vienna (Austria). Dec 1989. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.* Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

The multiple injection of deuterium pellets into JET plasmas under various scenarios for limiter and X-point discharges with currents up to 5 MA with pure ohmic, neutral beam and RF heating has been undertaken in a collaborative effort, between JET and an USDOE team under the umbrella of the EURATOM-USDOE (US Department of Energy) Fusion Agreement on Pellet Injection using an ORNL built 3-barrel, repetitive multi-pellet launcher. The best plasma performance with pellet injection and additional heating so far has been obtained by injecting early into 3 MA, 3.1 T pulses while centrally depositing the pellet mass, with n_{eo} initially well in excess of $10^{20}m^{-3}$. Subsequent central heating of this dense and clean core by ion cyclotron resonance heating (ICRH) with H and ^{3}He minorities in the 10 MW range yields T_{eo} up to 12 keV and T_{io} up to more than 10 keV, while n_{eo} is decreasing (within up to 1.5s) decaying to $0.6x10^{20}m^{-3}$, suggesting an enhanced central energy confinement in limiter discharges with only modestly improved global L-mode confinement. In this plasma core electron pressures of more than 1 bar with gradients in the order of 4 $bar*m^{-1}$ have been reached with the total pressure approaching ballooning stability limits. The resulting total neutron rate from D-D reactions of up to $4.5*10^{15}s^{-1}$ so far increases strongly with RF power and can exceed that of similar non-enhanced shots by factors of 3 to 5. $n_D(0)*T_i(0)*tau_E(a)$ products in the range of 1 to $2*10^{20}m^{-3}$keVs are obtained but combined power with neutral beams (up to 28 MW total) generally degrades the performance though leading to higher neutron rates of up to $7*10^{15}s^{-1}$. (author). 10 refs, 10 figs.

20885 (IAEA-TECDOC–534, pp. 51-58) **Pellets in large tokamaks TFTR and JET.** Schmidt, G.L (Princeton Univ., NJ (USA). Plasma Physics Lab.); Hammett, G.; Hulse, R.; Owens, D.K.; Baylor, L.R. JET/USDOE Pellet Collaboration. International Atomic Energy Agency, Vienna (Austria). Dec 1989. Contract DE-AC02-76-CHO-3073. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.* Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

In TFTR and JET experiments, pellet fueling has been extended to larger, higher temperature devices. We will review selected current results in the light of earlier experiments. Penetration depths are generally in agreement with modelling when ablation by thermal electrons dominates, but local deposition may differ from predictions based solely on the prepellet Te profile. Deposition at the plasma edge can be enhanced. Deposition near the plasma center may also be altered, particularly in JET. Fueling efficiency is high, but at present strongly peaked density profiles are obtained only with pellet penetration approaching or beyond the plasma center. Density achieved with pellets in ohmic plasmas is greater than that attainable with deuterium gas puffing in both these large devices as in previous experiments. Locked modes limit this density in JET but not yet in TFTR. Strong electron temperature perturbations can be tolerated in these large devices as on smaller machines allowing modification of the current profile leading to a change in the time evolution of the central q value and suppression of existing sawtooth relaxations or delay of their onset. In ohmic discharges plasma reheating is moderate, typically 1.5 keV. Axial voltage is maintained. Loss of central density can be extremely slow. Decay rates of 1.5 to 2 sec are observed. With heating, $T_e >$ 5 keV is rapidly achieved. Axial voltages may strongly decrease. Under these conditions central particle loss rates can be enhanced. Decay rates in JET at 5-8 keV are approximately 0.75 s. Energy confinement is observed to improve in TFTR ohmic discharges as was seen in earlier experiments. With beam heating in TFTR, central energy confinement was not degraded during the reheat following the pellet perturbation. However, central power deposition was low in these cases due to diminished beam penetration. (Abstract Truncated)

20886 (IAEA-TECDOC–534, pp. 59-65) **Pellet injection experiments in the JFT-2M tokamak.** Kasai, S. (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment). JFT-2M Group. International Atomic Energy Agency, Vienna (Austria). Dec 1989. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.* Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

The main objective of a pellet injection in JFT-2M is to improve the plasma March parameters, i.e. to achieve high confinement, high density and high beta plasmas. Neutral beam (NB) or ion cyclotron range of frequency wave (ICRF) heated JFT-2M discharges with gas fueling exhibit H-modes in divertor or limiter configuration. Deuterium pellets (speed: 0.7-1 km/s) were injected in the L- or H-mode phase of divertor discharges. A very high confinement mode was achieved as the large pellet Deltan-tilde$_e \simeq$ $3\text{-}4.5x10^{19}m^{-3}$ was injected in the L-mode phase. The maximum global energy confinement time ($tau_E=W_e/(P_t-dW_e/dt)$) is 60-75 ms in NB heating and 55-60 ms in ICRF heating, which exceed tau_E in gas fueled H-mode by a factor of 1.4-1.7. In ICRF heating, tau_E was also improved as the pellet was injected in the H-mode phase. In this case, pellet penetration depth is the same as that of injection in the L-mode of NB heating. With a small pellet (Deltan-tilde$_e$ <= $1.5x10^{19}m^{-3}$), large improvement of tau_E has not been obtained. High density plasmas were easily obtained by injection of 4 pellets with time interval of 30-50 ms. Maximum line-averaged electron density was $8x10^{19}m^{-3}$ (Deltan-tilde$_e \simeq 5x10^{19}m^{-3}$) in Ohmic heated discharges ($6x10^{19}m^{-3}$ for gas fueling) and $9.5x10^{19}m^{-3}$ (Deltan-tilde$_e \simeq 7x10^{19}m^{-3}$, Murakami factor $\simeq$ 9.7) in NB heated discharges. These results indicate that pellet injection is useful to improve the plasma parameters. (author). 6 refs, 7 figs.

20887 (IAEA-TECDOC–534, pp. 67-72) **Pellet injection in the RFP.** Wurden, G.A. (Los Alamos National Lab., NM (USA)); Weber, P.G.; Munson, C.P.; Cayton, T.E.; Bunting, C.A.; Carolan, P.G. International Atomic Energy Agency, Vienna (Austria). Dec 1989. Contract AT-05-10-11-A. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.* Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

Observation of pellets injected into the ZT-40M Reversed Field Pinch has allowed a new twist on the usual tokamak ablation physics modeling. The RFP provides a strong ohmic heating regime with relatively high electron drift parameter ($xi_{drift} \approx 0.2$), in the presence of a highly sheared magnetic field geometry. In situ photos of the pellet ablation cloud using a gated-intensified CCD

camera, as well as two-view integrated photos of the pellet trajectory show substantial modification of the original pellet trajectory, in both direction and speed. Depending on the launch geometry, increases in the initial 500 m/s pellet speed by 50% have been observed, and a ski jump deflector plate in the launch port has been used to counteract strong poloidal curvature. In contrast to the tokamak, the D_{alpha} light signature is strongest near the edge, and weaker in the plasma center. Additional information on ion temperature response to pellet injection with 20 musec time resolution has been obtained using a 5-channel neutral particle analyzer (NPA). The energy confinement is transiently degraded while the beta is largely unchanged. This may be indicative of pellet injection into a high-beta plasma operating at fixed beta. (author). 10 refs, 6 figs.

20888 (IAEA-TECDOC–534, pp. 73-80) **Pellet injection experiments on Heliotron E.** Sudo, S. (Kyoto Univ., Uji (Japan). Plasma Physics Lab.); Baba, T.; Sano, F. International Atomic Energy Agency, Vienna (Austria). Dec 1989. Contract 60460223. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.* Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

The overall feature of pellet injection experiments on Heliotron E, which does not need an external plasma current for plasma confinement in contrast with tokamaks, is described, including study of transport, MHD stability and ablation. (author). 10 refs, 10 figs.

20889 (IAEA-TECDOC–534, pp. 81-86) **Studies on H_2/D_2 pellet injection in JIPP-TIIU tokamak.** Sato, K.N. (Nagoya Univ. (Japan). Inst. of Plasma Physics). JIPP-TIIU Group. International Atomic Energy Agency, Vienna (Austria). Dec 1989. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.* Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

An ice pellet injector has been developed in order to study particle transport and confinement in the JIPP-TIIU tokamak. The pellet size is 1.0 and 1.4 mm and the speed is from 300 to 950 m/s. From an electron density perturbation by the pellet injection particle transport has been analyzed. The density profile factor k, defined as $n(r,t) = n(O,t)\{1 - (r/a)^2\}^{k(t)}$, changes rapidly by the injection and recovers gradually. Analysis is carried out in the recovery phase by using the integral form of the particle diffusion equation, where the source term at this phase is negligible around $r/a \approx 0.5$. The values D and v at $r/a \approx 0.5$ for ohmic plasmas are determined with good accuracy as 0.4 m^2/s and 4 m/s, respectively. In addition, the particle confinement time is obtained from the measurement by fast neutral particle analyzers, and the result is consistent with the particle diffusion coefficient. (author). 6 refs, 8 figs.

20890 (IAEA-TECDOC–534, pp. 89-96) **Prospectives of pellet injection in NET-like devices.** Engelmann, F. (Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)). NET Team. International Atomic Energy Agency, Vienna (Austria). Dec 1989. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.* Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

The prospectives of pellet injection in NET-like devices are discussed in the light of anticipated requirements for the control of the plasma density. (author). 9 refs, 3 figs, 1 tab.

20891 (IAEA-TECDOC–534, pp. 99-105) **Particle transport in pellet-fueled TFTR plasmas.** Hulse, R.A. (Princeton Univ., NJ (USA). Plasma Physics Lab.); Schmidt, G.L.; Efthimion, P. International Atomic Energy Agency, Vienna (Austria). Dec 1989. Contract DE-AC02-76-CHO-3073. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.* Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

Analysis of electron and ion particle transport in TFTR pellet-fueled plasmas has been carried out by detailed modeling of time-dependent electron density profiles and impurity radiation. TRIUMPH electron transport code results show the entire 1 to 2 seconds of post-pellet electron density evolution in ohmically heated, pellet-fueled plasmas to be reasonably well modeled using a time-independent $D(r) = D(O) + (D(a) - D(O))\,(r/a)^2$, together with the neoclassical electron particle flux. The derived D(O) is very low, in the range 50 approx 200 cm^2/s, while D(a) rises to 1,000 approx 5,000 cm^2/s. The development of centrally peaked density profiles on broad pedestals is seen to be the result of edge particle loss and replacement by edge sources after the pellet deposition. Sawtooth disruptions can dramatically flatten the central density profile, with observed re-peaking of the density between sawteeth consistent with the pre-sawtooth D(r) and neoclassical flux model. In these same ohmic discharges, MIST impurity transport code modeling of VUV, X-ray, and bolometric data for injected and intrinsic impurities indicates that adopting essentially the same D(r) for the impurity ions, together with their neoclassical flux, is a viable hypothesis. Given the low D(O) for these models, this results in strong on-axis peaking for the impurity ions. Similar modeling is currently being used to study the role of a reduced Ware pinch and enhanced diffusion in producing the density pump-out observed in similar neutral beam heated plasmas. (author). 5 refs, 6 figs.

20892 (IAEA-TECDOC–534, pp. 107-112) **Particle transport analysis of pellet fueled JET plasmas.** Baylor, L.R. (Oak Ridge National Lab., TN (USA)); Houlberg, W.A.; Milora, S.L.; Schmidt, G.L. JET/USDOE Pellet Collaboration. International Atomic Energy Agency, Vienna (Austria). Dec 1989. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.* Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

The analysis is carried out using a 1-1/2 D radial profile transport code modelling the experimental density evolution for given particle transport coefficients. These analyses are carried out in ohmic, RF heated, and NBI heated plasmas in both limiter and X-point configurations. We find that ohmic cases are generally characterized by hollow radial diffusion coefficients and can be satisfactorily modelled without any anomalous convective (pinch) term. Auxiliary heated cases show rapid pump out of density which can be explained by changes in the transport coefficients. Initial analysis of pellet and non-pellet fueled H-mode plasmas also can be explained by changes from the ohmic X-point case. In all cases neoclassical transport diffusion coefficients are substantially smaller than the determined values. (author). 9 refs, 3 figs.

20893 (IAEA-TECDOC–534, pp. 113-119) **Correlation of heat and particle transport in JET.** Gondhalekar, A. (Commission of the European Communities, Abingdon (UK). JET Joint Undertaking); Cheetham, A.D.; Haas, J.C.M. de. International Atomic Energy Agency, Vienna (Austria). Dec 1989. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.* Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

Radial thermal and particle diffusivities have been measured using transient methods, yielding chi and D simultaneously in the plasma interior at 0.5le$r$/ale0.7. $chi_e = 2.7 \pm 0.4\ m^2/s$ and $D_e = 0.4 \pm 0.1\ m^2/s$ have been measured in OH plasmas, giving $chi_e/D_e = 6.8 \pm 2.7$. NBI heated H-mode plasmas are indistinguishable from OH plasmas in respect of chi_e, D_e and chi_e/D_e. The ion thermal diffusivity has also been measured in H-mode plasmas, giving $1 < chi_i(m^2/s) < 3$, simultaneously with $chi_e = 3 \pm 0.5\ m^2/s$, thus $0.3 < chi_i/chi_e < 1$. The large value of chi_e/D_e would suggest that micro-magnetic stochasticity, rather than ExB convection, may be

the key mechanism in anomalous transport. (author). 17 refs, 4 figs, 1 tab.

20894 (IAEA-TECDOC–534, pp. 121-128) **Comparison of local transport studies with the profile consistency concept for ASDEX pellet-refuelled discharges.** Gruber, O. (Association Euratom-Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)); Kaufmann, M.; Lackner, K.; Mertens, V.; Sandmann, W. International Atomic Energy Agency, Vienna (Austria). Dec 1989. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.* Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

Strongly peaked electron density profiles have been obtained in ASDEX by different refuelling methods: pellet fuelling, NBI counter-injection and recently by reduced gas puff fuelling scenarios. These discharges show in common increased density limits, a canonical electron temperature profile independent of the density profile and an improvement of the particle and energy confinement. Whereas the changes in particle transport are not fully understood, local transport analyses point out that the improved energy transport can be explained by reduced ion conduction losses coming close to the neoclassical ones. The different results for the ion transport with flat and peaked density profiles are quantitatively consistent with that expected from eta_i-driven modes. So all cases showing confinement improvement through density peaking correspond to eta_i and $eta_e < 1$ over a large part of the plasma cross-section. With the ion transport behaviour emerging from our analysis, the saturation of tau_E with eta_e for flat density profiles and the extension of the linear dependence for peaked ones in OH discharges then fits with a continuing inverse density dependence of the electron thermal diffusivity chi_e is also in agreement with tau_E enhancement when going from D^+ to H^+ ions. With additional heating chi_e is largely responsible for the confinement degradation in the L-mode and again the improvement at the H-mode transition. Near the plasma boundary chi_e is higher than chi_i in all cases investigated. (author). 9 refs, 7 figs.

20895 (IAEA-TECDOC–534, pp. 137-142) **WHIST transport analysis of high-neutron-production, ICRF-heated, pellet-fueled JET plasmas.** Houlberg, W.A. (Oak Ridge National Lab., TN (USA)); Milora, S.L.; Tolliver, J.S.; Phillips, C.K. JET/USDOE Pellet Collaboration. International Atomic Energy Agency, Vienna (Austria). Dec 1989. Contract DE-AC05-84OR21400. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.* Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

The WHIST 1 1/2-D predictive transport code is used to model the particle and energy transport in JET plasmas with pellet fueling and ICRF heating. Pellet injection during the current rise phase was used to produce strong central peaking of the particle density, followed by central ICRF heating; this led to a transient period of enhanced confinement. The evolution of the density profile and of the electron and ion temperature profiles under strong ICRF heating conditions during this period of enhanced confinement is examined in the context of models for particle and energy transport. Because WHIST is a predictive transport code, it requires models for particle and energy sources and transport coefficients. The analysis procedure thus consists of modeling the particle source terms (pellets, gas, and recycled neutrals), energy source terms (Ohmic and ICRF heating), and energy loss terms (primarily radiation) and then varying the transport models until the best qualitative and quantitative agreement is obtained between calculated and observed quantities. We find that plasma behavior during the first second of ICRF heating following pellet injection is well described by the same transport coefficients that describe the Ohmic plasma. The distinction between electron and ion thermal losses depends on the relative heating rates of electrons and ions as determined by the ICRH model and on the radiation losses. (author). 10 refs, 3 figs.

20896 (IAEA-TECDOC–534, pp. 143-149) **Improved confinement with peaked density profiles in ohmically and neutral beam heated plasmas in ASDEX.** Soeldner, F.X. (Association Euratom-Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)); Gehre, O.; Gruber, O.; Kornherr, M.; Mueller, E.R.; Murmann, H.D.; Niedermeyer, H.; Staebler, A.; Wagner, F. International Atomic Energy Agency, Vienna (Austria). Dec 1989. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.* Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

New regimes of improved energy and particle confinement were found on ASDEX in gas fuelled ohmic discharges at high density and with neutral beam injection in counter direction (ctr-NI), respectively. In both cases the improvement in confinement is closely related to a peaking of the density profile. Peaking of $n_e(r)$ and a gradual rise of the energy content are triggered by a reduction of the external gas flux. In the improved ohmic confinement regime (IOC) the energy confinement time tau_E does not saturate with density up to the density limit. With ctr-NI, tau_E values up to 50% above the ohmic saturation level are obtained. With peaking of the density profile, the parameter $eta_i = L_n/L_{T_i}$ drops to 1 or below. Therefore the improvement in confinement might be explained by stabilization of the eta_i-modes. (author). 6 refs, 6 figs.

20897 (IAEA-TECDOC–534, pp. 159-165) **Impurity accumulation studies in pellet-refuelled ASDEX discharges.** Fussmann, G. (Association Euratom-Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)); Krieger, K.; Nolte, R.; Roehr, H.; Steuer, K.H. ASDEX Team. International Atomic Energy Agency, Vienna (Austria). Dec 1989. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.* Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

Pellet injection into ASDEX discharges allows considerable improvement of the confinement properties. Simultaneously with this improvement a strong accumulation of metallic impurities is observed, which leads to intolerable cooling of the plasma core region. We discuss the experimental phenomena and the underlying transport changes associated with the accumulation. (author). 9 refs, 6 figs.

20898 (IAEA-TECDOC–534, pp. 167-173) **Impurity accumulation after pellet injection in JET.** Behringer, K. (Association Euratom-Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)); Denne, B.; Gottardi, N.; Hellermann, M. von; Pasini, D. International Atomic Energy Agency, Vienna (Austria). Dec 1989. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.* Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

Centrally peaked electron density profiles lasting for several seconds are obtained by injection of one to several pellets into JET OH discharges. Subsequent ICRH and neutral beam heating result in high electron and ion temperatures on axis and narrow temperature profiles. Sawteeth are suppressed and only observed after final profile flattening. During post-pellet phases with and without additional heating, impurities accumulate on axis, as demonstrated by VUV and charge-exchange spectroscopy, as well as bolometer and soft X-ray radiation. Both light and medium-Z impurities develop profiles narrower than n_e in the plasma core region. The outer plasma zones continue to be dominated by anomalous transport. Impurity behaviour is well described by model calculations based on neoclassical transport, assuming reduced anomalous diffusion in the plasma interior. During additional heating, the existence of grad T_i driving forces is confirmed by the experiment. The zone with reduced transport appears to extend to half minor radius initially, and

to shrink later, leading to a reduction and the eventual disappearance of n_e peaking and accumulation. (author). 9 refs, 4 figs.

20899 (IAEA-TECDOC–534, pp. 175-180) **Evidence for light impurity peaking after pellet injection on TEXT.** Synakowski, E.J. (Texas Univ., Austin, TX (USA). Fusion Research Center); Bengtson, R.D.; Ouroua, A.; Wootton, A.J.; Kim, S.K. International Atomic Energy Agency, Vienna (Austria). Dec 1989. Grant DE-FG05-88ER53267. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.* Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

Light impurity density profiles following hydrogen pellet fueling have been obtained via charge exchange recombination spectroscopy on TEXT. C^{+6} and O^{+8} peak much more strongly on axis than the electron density following hydrogen pellet fueling, in contrast to gas puff fueled discharges. The peaked pellet impurity profile shapes are described by neoclassical theory while measured transport coefficients are larger than neoclassical values. (author). 13 refs, 4 figs.

20900 (IAEA-TECDOC–534, pp. 181-187) **Measurement of the current density profile and modification of the electron density profile in tokamaks using low Z impurity pellets.** Marmar, E.S. (Massachusetts Inst. of Tech., Cambridge, MA (USA). Plasma Fusion Center); Terry, J.L.; Rice, J.E.; Lipschultz, B. International Atomic Energy Agency, Vienna (Austria). Dec 1989. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.* Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

High speed lithium pellets have been injected into Alcator C tokamak plasmas in order to measure the internal magnetic field, and thus current density profiles. In the pellet ablation cloud, intense visible line radiation from the Li^+ ion (lambda approx. 5485 A, $1s2s\ ^3S$ -$1s2p\ ^3P$) is polarized due to the Zeeman effect, and measurement of the polarization angle yields the direction of the total local magnetic field. A "snap shot" of the q profile is obtained as the pellet penetrates from the edge into the center of the discharge, in a time of approx. 300 mus. The spatial resolution of the measurement is about 1 cm. At a toroidal field of B_T = 10 Tesla, the emission in the unshifted pi component of the Zeeman triplet is more than 90% polarized, and q profiles have been obtained. The pellets are perturbative ($<Deltan_e>/<n_e>$ approx. 1), but the total pellet penetration time is at least a factor of 1000 smaller than the classical skin time. It can thus be anticipated that the current density profile should not be perturbed significantly during the time of the measurement. The pellets also fuel the plasma, and essentially every phenomenon observed with deuterium pellet fueling of Alcator C has also been seen with lithium pellets. These include increased energy confinement time, enhancement of the global D-D fusion reaction rate, and peaking of the density profiles. The replacement of lithium by deuterium as the discharge evolves following the injection of a single lithium pellet has also been measured. A new two shot pellet injector has been built in order to continue these experiments on the TFTR tokamak at Princeton. It is capable of injecting lithium and carbon pellets, with velocities up to 1.1×10^5 cm/s. An improved polarimeter/spectrometer system has also been constructed and tested. (author). 10 refs, 8 figs.

20901 (IAEA-TECDOC–534, pp. 191-196) **Pellet ablation and temperature profile measurements in TFTR.** Owens, D.K. (Princeton Univ., NJ (USA). Plasma Physics Lab.); Schmidt, G.L.; Cavallo, A. International Atomic Energy Agency, Vienna (Austria). Dec 1989. Contract DE-AC02-76-CHO-3073. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.* Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

Single and multiple deuterium pellets have been injected into a variety of TFTR plasmas, including ohmically heated plasmas with a range of initial electron temperatures, neutral beam heated plasmas at several NBI powers and high T_e, post NBI plasmas. Pellet penetration into these plasmas was determined by measuring the pellet speed and duration of the H_{alpha} light emission during pellet ablation in the plasma. These penetration measurements are compared to the predicted penetration computed using the ablation model developed by Oak Ridge National Laboratory. Provided super- thermal electrons are not present in the target plasma, reasonable agreement is found between the model and measurements of the penetration for a particular choice of the free parameter in the model. Neutral beam particles have a substantial effect on the ablation rate of pellets in low T_e plasmas (T_e < 4 keV) while in high T_e plasmas the electron driven ablation dominates. A more detailed examination of the fuel deposition profile will be presented as well as a preliminary discussion of the electron temperature profile evolution. (author). 3 refs, 10 figs.

20902 (IAEA-TECDOC–534, pp. 197-203) **Magnetic surfaces and striations during pellet ablation.** Pegourie, B. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee); Dubois, M.A. International Atomic Energy Agency, Vienna (Austria). Dec 1989. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.* Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

The striations observed on the Halpha or Hbeta emission signal of ablated pellets are not presently well understood. A limitation of the ablation process due to the lesser amount of energy available on resonant magnetic surfaces would be an attractive explanation. In order to evaluate the ability of the latter to produce the observed features, we developed a model which takes into account the maxwellian distribution of electrons, the proportion of trapped particles, the geometrical effects linked to the shear and the finite lifetime of the filaments. In tokamaks, it is found that our model is unable to reproduce the observed striations for smooth q profiles but that the general shape of the Halpha (or Hbeta) signal can be fitted by introducing small flattenings (e.g. small magnetic islands) around resonant surfaces. In low-shear stellarators, striations (rather shallow) due to rational q values can exist in the absence of magnetic islands but require the presence of a suprathermal electron tail. (author). 17 refs, 2 figs, 1 tab.

20903 (IAEA-TECDOC–534, pp. 129-135) **Experimental observation of eta_i-mode suppression by density profile modification through pellet injection.** Brower, D.L. (California Univ., Los Angeles, CA (USA). Inst. for Plasma and Fusion Research); Peebles, W.A.; Kim, S.K. International Atomic Energy Agency, Vienna (Austria). Dec 1989. Contract DE-AC05-78ET53043;Contract DE-FG03-86ER53225. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.* Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

For high-density ohmic discharges in the TEXT tokamak, a distinct ion mode (i.e. density fluctuations propagating in the ion diamagnetic drift direction) is observed in the microturbulence spectra. The magnitude and spectral characteristics of the mode are identified. A microinstability based transport model is used for the purpose of interpreting anomalous confinement properties. Onset of the ion feature occurs at plasma densities where a clear saturation is evident in the global energy confinement time tau_E. When the ion feature in the fluctuation spectra is strongest, agreement between predictions from the transport model and experimentally measured values of the global energy confinement time is only realized when anomalous ion effects due to the ion-pressure-gradient-driven (eta_i) instability are included. By injecting pellets, a high-density plasma is created in which the density profile is sharply peaked. Under

these conditions the ion feature in the fluctuation spectra is suppressed. Possible connection between this experimentally observed ion mode and the theoretically predicted properties of the eta_i instability is explored. (author). 23 refs, 3 figs, 1 tab.

20904 (IAEA-TECDOC–534, pp. 153-158) **Current profile modification and MHD activity following pellet injection in Alcator C.** Greenwald, M. (Massachusetts Inst. of Tech., Cambridge, MA (USA). Plasma Fusion Center); Granetz, R.; Petrasso, R.; Terry, J. Alcator C Group. International Atomic Energy Agency, Vienna (Austria). Dec 1989. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.* Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

Pellet fueling experiments on Alcator C focussed on the regime of improved energy and particle confinement, where it was observed that transport for the ionic species was reasonably well described by neo-classical theory. Ion energy transport dropped and particle confinement, particularly for impurity species increased dramatically. These effects have been ascribed to the suppression of ion temperature gradient driven modes (eta_i) by the peaked density profile set up by pellet injection. Although radiation by high Z ions was unimportant in these discharges, the accumulation of low Z impurities, principally carbon, had a profound effect on the discharge by peaking the resistivity profile and reducing the current density near the plasma center. One result of this was a modification of sawtooth activity; a lengthening of the period between sawteeth and ultimately their complete suppression. After suppression of the sawteeth, very large amplitude m=1, n=1 oscillations were often observed. The appearance of this mode was often correlated with saturation of impurity confinement. We speculate that this mode is a form of the m=1 ideal mode that has been held responsible for the sawtooth crash. (author). 14 refs, 5 figs.

20905 (IAEA-TECDOC–534, pp. 231-236) **Pellet injection into ohmically and additionally electron cyclotron resonance heated tokamak plasmas.** Drawin, H.W. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee); Geraud, A. International Atomic Energy Agency, Vienna (Austria). Dec 1989. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.* Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

Frozen H_2 and D_2 pellets were injected into ohmically and additionally electron cyclotron resonance heated (ECRH) plasmas of the FONTENAY-AUX-ROSES tokamak TFR. Without ECR heating the pellets penetrate deeply into the plasma and the ablation clouds are striated. The ablation rate is higher than predicted by the neutral shielding model. Pellet injection during ECRH leads to enhanced ablation in the outer plasma region. The position of the ECR layer has practically no influence on the penetration depth which is reduced to a few centimeters. On the photographs the ablation clouds show no particular structure when ECRH is applied. Only 2/3 of the pellet mass is found as ionized matter in the plasma, compared to the ohmic case. Radial electron density profiles have been simulated and compared with the measured ones. Broad quantitative agreement is obtained when one assumes that in the presence of ECR waves a low-density, hot electron group causes enhanced ablation in the plasma periphery and the limiter shadow. (author). 21 refs, 6 figs.

20906 (IAEA-TECDOC–534, pp. 205-215) **General remarks concerning the ablation of a fuelling pellet.** Chang, C.T. (Euratom-Riso Association, Risoe National Lab., Roskilde (Denmark)). International Atomic Energy Agency, Vienna (Austria). Dec 1989. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.* Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

According to the general accepted view, the main shielding effect of a hydrogen (or its isotopes) pellet subjected to the impact of plasma electrons is due to the presence of a highly dense cloud around the pellet. Assuming the stopping power process is valid for particles of any species and using dimensional reasoning, the particle ablation rate of a pellet subjected to the impact of particle beam of that species at the energy E and number density n can be shown, is given by $N=(n/m)^{1/3}(1/m)^{1/6}E^{1/2}f(r^2/A^i)$ where m is the molecular weight of the pellet material, A^i is the energy flux attenuation cross section of the incident particle of species with respect to the target particle of the "ith constituent" of the ablatant. When most energy of the incident particle is effectively absorbed in a spherical shell around the pellet, the ablation rate N can be simplified to $N=(n/m)^{1/3}r^{4/3}f(E)$. Generalization to a multi-species ablatant does not change the scaling law of pellet ablation rate. Finally, the ablation rate of a pellet subjected to the impact of particles of known energy distribution can be obtained by taking the proper moment of Eq. (2). The possible existence of an effective spherical energy absorbing region of the gas-shielding model for the pellet ablation is examined by considering the ablatant as composed of our species: H_2, H, H^+ and e^-. The ablated cloud expands spherically if the local collisional mean free path of the cold ablated electrons is much less than the local electron Larmor radius. Results of the analysis showed that for magnetic field strength prevailing in most of the present tokamaks such a region exists at a distance of about 2r where approximately 80% of the incoming electron energy flux is absorbed. 28 refs, 2 figs, 1 tab.

20907 (IAEA-TECDOC–534, pp. 217-223) **JET pellet ablation studies and projections for CIT and ITER.** Houlberg, W.A. (Oak Ridge National Lab., TN (USA)); Milora, S.L.; Baylor, L.R.; Watkins, M.L. JET/USDOE Pellet Collaboration. International Atomic Energy Agency, Vienna (Austria). Dec 1989. Contract DE-AC05-84OR21400. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.* Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

Pellet penetration in JET under a wide variety of plasma conditions is analyzed and compared with the predictions of the neutral and plasma shielding (NGPS) model for pellet ablation. Specific issues addressed in the context of the NPGS model that impact pellet ablation are the effective ionization radius of the ablatant normal to the magnetic field and the role of non-Maxwellian ions and electrons in the ablation process. The model is then used to evaluate pellet penetration in CIT and ITER. Nearly all non-ohmic heating techniques produce small populations of energetic electrons or ions. Slowing-down distributions of hydrogenic and helium ions can be used to evaluate thresholds for neutral beam injection and fusion alpha enhanced ablation respectively. Pellet ablation in neutral beam heated plasmas agrees with the fast ion treatment in the NGPS model. Classical, local thermalization of alphas from thermal reactions is shown to lead to no significant pellet ablation enhancement. Energetic distributions without a sharp energy cutoff, as produced with RF heating or runaway discharges, are far more difficult to analyze with simplifying approximations. Projections for CIT and ITER show that active fueling of the outer half of the plasma volume is most probable for the pellet sizes and velocities considered. Penetration to the plasma center is highly unlikely at the nominal design operating conditions. Thus, it is important to understand transient particle transport under conditions of partial pellet penetration. (author). 13 refs, 2 figs, 2 tabs.

20908 (IAEA-TECDOC–534, pp. 225-230) **Status of pellet-plasma interaction studies at Garching.** Lengyel, L.L. (Association Euratom-Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)); Lalousis, P.J. International Atomic Energy Agency, Vienna (Austria). Dec 1989. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet*

injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988. Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

Massive neutral particle sources, such as pellets injected into tokamaks, may notably affect both the local state parameters of the target plasma and the equilibrium state of the discharge at large. Indeed, since the energy influx affecting the neutral mass locally deposited is defined by the thermal or directed velocities of the energy carriers in the hot background plasma (thermal electrons, etc.), and the energy efflux from the source region is defined by the hydrodynamic (convective) velocity of the cold particles heated, the deposited mass may serve as a transient energy accumulator that deplates the energy of the rest of the energy reservoir (flux tube) affected, and may have state parameters much different from those of the background plasma. The local disturbance amplitudes caused by ablating pellets in tokamaks can be computed by means of a hydrodynamic model supplemented by the neutral-gas-plasma-shielding ablation model. The model computes, for a given local particle deposition rate, the time histories of the ablatant cloud parameters such as cloud radius, cloud length, electron density, temperature, cloud beta, etc. at a succession of magnetic flux surfaces. Computations have been performed for a number of tokamaks with different plasma parameter ranges (TFR, T-10, ASDEX, JET, NET, etc.) and the results are compared with the experimental data available (PLT, TFTR, ISX-B, TFR, and TEXT). The feedback between the local plasma parameter disturbances and the ablation rates calculated as well as the problems associated with predictive calculations are discussed. (author). 4 refs, 3 figs.

20909 (IAEA-TECDOC–534, pp. 297-307) **Transport modification through pellet injection.** Lackner, K. (Association Euratom-Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)). International Atomic Energy Agency, Vienna (Austria). Dec 1989. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.* Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

Highlights from the theoretical papers presented at the IAEA Technical Committee Meeting on Pellet Injection and Toroidal Confinement on transport modification in discharges with pellets are summarized: Energy transport by electrons and ions and particle transport are discussed with emphasis on experimentally observed features produced by injecting pellets into the large tokamaks. (author). 33 refs, 4 figs.

20910 (IAEA-TECDOC–534, pp. 309-316) **Changes in impurity particle transport following the injection of fueling pellets into tokamak discharges.** Marmar, E.S. (Massachusetts Inst. of Tech., Cambridge, MA (USA). Plasma Fusion Center). International Atomic Energy Agency, Vienna (Austria). Dec 1989. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.* Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

Improvements in the energy confinement properties of tokamaks have been achieved by means of central fueling with solid hydrogen pellets. Evidence from laser scattering experiments indicates that the reduced anomalous transport may be due to the suppression of eta$_i$ driven modes. These changes in energy transport, which appear to be primarily in the ion channel, are accompanied by changes in majority species and impurity transport. In particular, for discharges showing enhanced confinement, electron density profiles remain peaked for long periods following the injection of even a single pellet, and impurity accumulation on axis is observed. Other enhanced confinement modes also show similar changes in particle and impurity transport; similarities with, and differences from, the pellet induced changes are discussed. (author). 19 refs, 3 figs.

20911 (INIS-SU–151) **Using submillimeter lasers in interferometers for the diagnostics of high-temperature plasma.** Shcherbov, V.A.; Kuleshov, E.M.; Nesterov, P.K. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Inst. Radiofiziki i Ehlektroniki. 1988. 12p. (In Russian). Order Number DE90616858. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Expediency of using submillimeter laser in interferometers for the diagnostics of high-temperature plasma is substantiated. Positive and negative features of gas lasers while using the latter in SHF interferometers schemes have been analysed. Short information is given concerning the application of lasers in interferometers for plasma diagnostics in the USSR and the main requirements to them have been formulated. The main characteristics of laser interferometers worked out in the IKE Ac. Sci. Ukr. SSR for the thermonuclear synthesis installations Tokamak 10, Tokamak 7 and Tokamak 15 of the IAE named after Kurchatov are described. 20 refs.; 2 figs.

20912 (INIS-SU–152/A) **Nine-channel laser interferometer for measuring of electron concentration in plasma on Tokamak-15 installation.** Kuleshov, E.M.; Shcherbov, V.A.; Kamenev, Yu.E.; Nesterov, P.K.; Kononenko, V.K. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Inst. Radiofiziki i Ehlektroniki. 1988. 19p. (In Russian). Order Number DE90616859. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The results are given of the development and experimental investigation of the laboratory model of a nine-channel homogyne laser interferometer with the wavelength 337 mum. The interferometer is for use in measuring of spatial distribution of the electron concentration at vertical plasma sounding on the Tokamak-15 installation. Round hollow dielectric beamguide is used as a quasi-optical transmission line. The construction is described and the results are given of experimental investigation of the HCN-laser with high-frequency pumping, low-temperature receiver made on the basis of n-InSb monocrystal and frequency shifter. The results of the experimental investigation of the interferometer are given as well as the analysis of the measurement errors of phase shifts is made which bear out the working capacity of the device. 12 refs.; 8 figs.; 1 tab.

20913 (IPP–6/283) **A sufficient condition in resistive MHD.** Tasso, H. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Oct 1989. 6p. Order Number DE90753674. Available from NTIS (US Sales Only), PC A02/MF A01.

A sufficient stability condition with respect to purely growing modes is derived for resistive MHD. Though it may be, in general, violated, its ability to reduce in the appropriate limits to known necessary and sufficient stability conditions makes it instructive and conceptually useful. (orig.).

20914 (Juel–2238) **On the two time scales of the sawteeth precursors.** Rogister, A.; Singh, R. Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Plasmaphysik; Association Euratom-Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Oct 1988. 17p. Order Number DE90753676. Available from NTIS (US Sales Only), PC A03/MF A01.

For current profiles with a slope discontinuity at ϵ_2 close to ϵ_1 [$q(\epsilon_1)=1$] and a small shear s (ϵ_1), the jump of the derivative of the magnetohydrodynamic (MHD) solution across the singular q=1 layer is of the form $[\Psi']_{\epsilon 1} \simeq s_1[1-4f(\mu)\ \epsilon_1^2/s_1^2]$; ϵ is the finite inverse aspect ratio; $\mu=s_1\ \epsilon_1/8\ (\epsilon_2-\epsilon_1)$ measures the ratio of the two small parameters. The growth rate of the sawtooth trigger can accordingly pass from resistive to MHD values for slight variations either of s_1 or of $(\epsilon_2-\epsilon_1)/\epsilon_1$. The above profile properties have been observed in sawtoothing TEXTOR discharges. (orig.).

20915 (LA-UR–90-608) **Plasma simulation on magnetohydrodynamic time scales.** Brackbill, J.U. Los Alamos National Lab., NM (USA). [1990]. 7p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-900343–4: Supercomputing in nuclear applications, Mito City (Japan), 12-16 Mar 1990). Order Number DE90007490. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Progress in the development of implicit-moment methods for plasma simulation on magnetohydrodynamic time scales is described. The objective of the development is a method that is applicable not only to transport phenomena on long time scales,

but also to plasma interactions with a wall and sheath formation. The implicit field equations for a plasma in a dc magnetic field are given, and a method is described for their solution. An adaptive grid formulation is outlined, and a problem initialization presented to illustrate its application. The issue of nonlinear stability, which is still unresolved, is reviewed. 23 refs., 3 figs.

20916 (LRP–379/89) **Toroidal effects on current driven modes in tokamaks.** Turnbull, A.D. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Troyon, F. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Jun 1989. 49p. Order Number DE90616874. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The low beta stability of a toroidal circular cross-section tokamak is reanalyzed. Although the structure of the unstable modes can be considerably modified by toroidal coupling, the overall stability picture is well represented by the so-called straight tokamak model, with the major exception that the internal kink, although stabilized by toroidal effects, still has a free-boundary counterpart -the toroidal kink mode. The toroidal kink is unstable for $q_o < q_c \le 1$ and is destabilized by toroidal coupling, having a growth rate gamma that scales with inverse aspect ratio a/R like gamma $\approx (a/R)^2 [q_s]$, where $[q_s]$ is the integer part of the edge safety factor q_s. (author) 19 figs., 20 refs.

20917 (PPPL–2671) **Diagnostic applications of transient synchrotron radiation in tokamak plasmas.** Fisch, N.J. (Princeton Univ., NJ (USA). Plasma Physics Lab.); Kritz, A.H. Princeton Univ., NJ (USA). Plasma Physics Lab. Feb 1990. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03073. Order Number DE90005814. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Transient radiation, resulting from a brief, deliberate perturbation of the velocity distribution of superthermal tokamak electrons, can be more informative than the steady background radiation that is present in the absence of the perturbation. It is possible to define a number of interesting inverse problems, which exploit the two-dimensional frequency-time data of the transient radiation signal. 17 refs.

20918 (SAIC–87/3044-APPAT-91) **Influence of ICRF [ion cyclotron range of frequencies] power on drift wave stability and transport in tokamaks: Final report.** McBride, J.B. Science Applications International Corp., San Diego, CA (USA). 17 Jun 1987. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract FG03-86ER53239. Order Number DE90007267. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This reports presents the results of a theoretical study of radio frequency (rf) wave interactions in the ion cyclotron range of frequencies (ICRF) with dissipative trapped electron mode (DTEM) in tokamaks. This section contains a brief background discussion and summarizes the main results and conclusions of the study.

20919 (SAND–89-7155) **Analysis of the 1989 in-plasma B-dot probe experiments on the Sandia PBFA II plasma opening switch (POS).** Payne, S.S. (Mission Research Corp., Albuquerque, NM (USA)). Sandia National Labs., Albuquerque, NM (USA); Mission Research Corp., Albuquerque, NM (USA). Nov 1989. 119p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Contract No. 40-0129. Order Number DE90006463. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

We report on work performed from 14 March 1989 to 01 October 1989 in support of the plasma opening switch experiments performed at Sandia National Laboratories (SNL). Updates to the Sandia MACH2 version 8901 have been made. In-plasma diagnostic B-dot probe experimental data is presented with analysis. Significant azimuthal temporal differences in B-dot traces indicate switch plasma non-uniformities. Possible electron strikes to the in-plasma probes make amplitude values suspect; however, calibration shows that the timing is dependable. 7 refs., 115 figs.

20920 **The physics of laser plasma interactions.** Frontiers in Physics. Volume 73. Kruer, W.L. 199p. Addison-Wesley Publishing Co., Reading, MA (US) (1988).

The interactions of laser plasmas are considered theoretically in an introduction for advanced students and practicing scientists. Chapters are devoted to the basic concepts and two-fluid descriptions of plasmas, computer simulations of plasmas using particle codes, EM wave propagation in plasmas, propagation of obliquely incident light waves in inhomogeneous plasmas, collisional absorption of EM waves, and parametric excitation of electron and ion waves. Consideration is given to stimulated Raman and Brillouin scattering, heating by plasma waves, density-profile modification, the nonlinear features of underdense plasma instabilities, electron energy transport, and laser plasma experiments. 94 refs.

20921 **Experimental determination of plasma armature properties using RGS-II, a railgun simulator.** Baker, M.C. (The Univ. of Texas at Arlington, Center for Energy Conversion Research, P.O. Box 19380, Arlington, TX (US)); Barrett, B.D.; Pickens, T.J.; Nunnally, W.C.; Thompson, J.E. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The efficiency of plasma driven railguns is limited by losses associated with the plasma armature and its interaction with the railgun bore materials. These losses are responsible for velocity saturation, such that an increase in input energy does not yield a corresponding increase in projectile velocity. Experimental observation of the railgun plasma and direct measurement of plasma constituents and properties such as electron density, plasma temperature and current density can provide useful information for determining the nature of velocity saturation and other efficiency losses in plasma driven railguns. This paper describes an experimental device, RGS-II, that has been developed to provide a moving plasma armature without a projectile at current and velocity levels similar to those in railguns, by simulating the mass of the projectile with the magnetic back pressure of a muzzle fed current pulse. This devise is suitable for the implementation of diagnostic techniques due to the lack of a projectile in the bore. Results from data taken as a function of plasma current and ambient chamber pressure are presented in this paper. The data allow for a preliminary picture, based on the experimental data, of the moving plasma arc and its properties.

20922 **Reflection of an impulsive plane wave by a switched plasma medium.** Goteti, V.R. (Dept. of Electrical Engineering, Univ. of Lowell, Lowell, MA (US)); Kalluri, D.K. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The effect of switching a plasma medium on a traveling wave is shown to be the creation of waves with frequencies different from the incident wave frequency. The dispersive effect of this phenomenon is studied by considering the incident wave to be an impulsive plane wave. The electric field of the wave is assumed to be e-bar$_i$(z,t) = x δ (t + t_1-z/c). At time t=0 the entire space is converted to a lossless isotropic plasma characterized by a constant plasma frequency ϵ_ρ. Analytical expression for the electric field for $t > 0$ is obtained by treating the problem as an initial value problem in time domain. It is assumed that the free electrons continue to be at rest over the time discontinuity and are set in motion only for $t > 0$. This leads to the continuity of the tangential components of electric and magnetic fields over the temporal discontinuity. It is shown that for $t > 0$ the fields can be represented as a sum of waves propagating in the positive and negative z directions. The electric field is shown. This analysis is extended to the propagation of turned-on waves in a switched plasma medium. The results are discussed.

20923 **Effect of switching-off of a plasma medium on a traveling wave.** Kalluri, D.K. (Dept. of Electrical Engineering, Univ. of Lowell, Lowell, MA (US)). pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

It is known that a sudden creation of a plasma medium of plasma frequency ω_p splits a traveling wave of frequency ω_o into two new waves of frequencies. The negative value for the frequency here indicates a reflected wave. The effect of a sudden collapse of the plasma medium, on a travelling wave of frequency ω_o is shown to be the creation of two new waves of frequencies. A numerical solution is obtained for the case of a gradual collapse of the plasma medium. For the case of a slow decay of the particle density an approximate WKB type solution is obtained. Several results are presented.

20924 **Plasma heating by collisional magnetic pumping in a steady-state modified penning discharge.** Wu, M. (Tennessee Univ., Knoxville, TN (USA). Dept. of Electrical and Computer Engineering); Roth, J.R. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

This paper describes the experimental application of collisional magnetic pumping to heat a plasma by a sawtooth magnetic perturbation, and provides results relating to the energy transfer process between the perturbed magnetic field and the parallel and perpendicular energy components of the heated species in a steady-state modified Penning discharge apparatus with a magnetic mirror configuration. Experimental data is discussed, and heating of ions and electrons as functions of magnetic induction, electron number density, and natural gas pressure is presented. The detailed design of the above apparatus is presented and discussed.

20925 **Investigation of the nonlinear behavior of a weakly-ionized plasma.** Stafford, S. (Tennessee Univ., Knoxville, TN (USA). Dept. of Electrical and Computer Engineering); Roth, J.R. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

This paper describes recent progress on the application of chaos theory to a steady-state magnetized plasma. This research was conducted on a classical Penning discharge, which is inherently turbulent. This rules out the possibility of observing a transition from coherency to turbulence. However, by choosing appropriate boundary conditions, it was possible to produce relatively coherent modes. This was achieved by using a long cylindrical anode and a coaxial cathode. This arrangement creates a constant radial electric field along the axis, which in turn causes an E x B instability to develop in the edge region of the plasma. These modes can be damped or enhanced by varying the plasma parameters. Turbulence data were obtained by using a capacitive probe to measure the potential fluctuations. The signals were digitized and recorded with a LeCroy data acquisition system interfaced to an IBM AT computer. The goal of the reported research was to look for evidence of low dimensional chaos. Another was to look for a trend, or lack of tend, that related the state of turbulence to the plasma parameters.

20926 **RFP behavior at various F values in the MST.** Shen, W. (Wisconsin Univ., Madison, WI (USA). Dept. of Physics); Beckstead, J.A.; Chartas, G.; Hokin, S.A.; Prager, S.C.; Rempel, T.D.; Spragins, C.W.; Dexter, R.N. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Plasma behavior is tracked as the reversal parameter F (Bt(a)/<Bt>) is varied from -0.3 to 0.2 with corresponding pinch parameter θ (Bp(a)/<Bt>) from above 1.8 to under 1.2. The general plasma properties are quite similar for all F values, although some significant differences of detailed properties exist: Both magnetic and electrostatic fluctuations are minimum when the reversal is shallow (F = -0.1); plasma resistance is minimum and the conductivity temperature is maximum at shallow reversed plasma; and enhanced plasma-wall interaction is found when F>0. Periodic oscillations called flux jumps, or sawtooth oscillations, are seen on various diagnostics throughout most of the F-scan, but the dependence of jump amplitude and frequency on F is noted also. High frequency (10 - 15 kHz) precursors additional to flux jumps, associated with higher plasma temperature and longer plasma duration time, are seen on magnetic pickup coils and SXR detectors. Plasma under various discharge conditions, such as utilizing He as working gas, inserting graphite paddle, varying the amount of gas puff, and deliberately puffing impurity gas (Ne) are obtained and compared with standard discharges. A comparison with results from other machines (HBTX-1B, 1C, ZT-40, 40M) is presented.

20927 **Rail and insulator spectra from plasma railgun armatures.** Keefer, D. (Tennessee Univ., Tullahoma, TN (USA). Space Inst.); Sedghinasab, A. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Simultaneously, high resolution, radiation spectra of the plasma armature in the UTSI railgun have been recorded with optical multichannel analyzers (OMA) using 1 mm quartz fiber optics through both the rail and the insulator at the same axial location. The spectra have been obtained at approximately 6 mm and 24 mm from the leading edge of the armature which correspond to the increasing current and peak current parts of the plasma armature. The gate width was 1μs resulting in a spatial resolution of about 1.5 mm. The rail emission signal follows the armature current profile very closely, while the radiation through the insulator side is partially blocked due to ablation products in the insulator boundary layer. Resonance absorption lines of AlI, CuI and CaII have been identified along with possible traces of carbon and nitrogen compounds. A detailed radiation model is used to estimate the plasma centerline temperature, the temperature profile, and the plasma composition by predicting the radiance seen at the rail and the insulator walls, and comparing them with the experimentally obtained spectra.

20928 **A low frequency (100 MHz) cross-field amplifier device for measurements of RF wave-electron interactions.** Browning, J.J. (Dept. of Electrical and Computer Engineering, and Center for Electromagnetics Research, Northeastern Univ., Boston, MA (US)); Chan, C.; Ye, J. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

A device has been constructed in order to investigate wave-particle interactions in a cross-field amplifier (CFA). This device will be used to make measurements of the electron plasma, of rf fields, and of noise sources in an operating CFA using standard plasma diagnostics. Investigations of ponderomotive force effects on phenomena such as soliton formation and convective cells are also planned. The slow wave circuit is 40 cm long and 25 cm wide. An amplifier can provide up to 250 W of power at a frequency of 100 MHz. The slow wave wavelength is predicted to be 4 cm. The characteristic impedance of the circuit is predicted to be 55 Ω, so matching problems should not be significant. The static magnetic field is provided by two coil sets configured as Helmholtz coils with fields up to 80 Gauss. The cathode is made of Al-2024 and can be biased to -2.5 kV. In addition, there are tungsten filaments for the first 10 cm of the cathode in order to provide a good starting electron density as well as to allow for control of that density. Directional couplers are used to provide power measurements. Data is presented on the characterization of the CFA circuit and on the initial operating performance of the CRFA. Numerical simulations of the device, which indicate that operations as a CFA is possible, are presented and discussed.

20929 **Ion temperature in the Reversatron II RFP.** Greene, P. (Colorado Univ., Boulder, CO (USA)); Robertson, S. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

A seven-channel, f14 polychrometer with UV quartz optics has been constructed for ion temperature measurements on the Reversatron II RFP. The spectrometer has a focal length of 1.1 m and utilizes an 1800 1/mm grating. The spectrum is spread over a linear array of photomultiplier tubes by a 2 mm diameter quartz cylinder lens. Resolution is below 0.1 A and channel separation is 0.4 A. Initial measurements have been made in 25 kA helium discharges with no conducting-shell surrounding the resistive vacuum chamber. The HeI line at 3888 A which is predominantly from the plasma edge indicates $T_1 \approx 8$ eV. The HeII line at 4685 A which is less weighted by the edge indicates $T_1 \approx 17$ eV. A search is being made for impurity lines which are indicative of the central region of the discharge. Similar measurements will be made with other boundary conditions.

20930 Argon transition probabilities revisited. Sedghinasab, A. (Tennessee Univ., Tullahoma, TN (USA). Space Inst.). pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184--: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

In a recent paper, 2λ interometric technique is used to determine the electron number density, n_e, in pure argon plasma generated in a wall stabilized arc. Hydrogen is then added to obtain the reduced linewidth of the Balmer line H_β and results are compared to those give by GKS, KG, and VCS. The authors have then used the electron density correction factor based on the reduced linewidths $\alpha_1 2/$, and the assumption of LTE, to correct the transition probabilities, A, obtained from experiments using hydrogen for n_e determination. This result neglects the temperature change due to the modification to the electron density and hence yields a transition probability correction factor which is independent of n_e and T. In this paper, the authors show that this correction factor is invalid and results in transition probability corrections which are in error by 30-200%.

20931 A 0.1 TW gas-breakdown plasma-anode ion diode. Dunning, A. (Cornell Univ., Ithaca, NY (USA). Lab. of Plasma Studies); Greenly, J.B.; Rondeau, G.D. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184--: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

A magnetically-insulated extraction-geometry ion diode using inductive breakdown of a gas layer to produce a magnetically-confined anode plasma has been successfully operated on the LONGSHOT pulser: 120 kV, 30 kA, $\leq 1\,\mu$s. This LONGSHOT diode doubled the total ion output compared to a standard dielectric anode, allowed constant impedance for $\geq$ 500 ns, and improved upon all other characteristics except beam divergence. The plasma anode has now been integrated into a similar diode to operate on the Neptune pulser: 700 kV, 3Ω, 100 ns, $\geq$ 0.1 TW. The goal is to investigate the scaling of this diode to the higher voltage, and to current density above 0.5 kA/cm^2. The major scaling issue is whether good control can be maintained of the anode surface shape and position, and the resulting ion canonical momentum and divergence. The beam from this diode will be used to form diamagnetic ion rings, and will allow good diagnosis of beam quality. First experimental results are presented.

20932 Particle and power balances of hot-filament discharge plasmas in a multi-dipole device in the presence of a positively biased electrode. Cho, M.H. (Wisconsin Univ., Madison, WI (USA)); Hershkowitz, N.; Intrator, T. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184--: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The plasma potential is typically assumed to float above an anode potential by a few times of an electron temperature (T /e). The difference between the plasma potential and the anode potential can be estimated by considering the particle production and loss. However, it has been reported experimentally that the plasma potential of a steady state plasma can be more negative than the anode potential with a potential dip (– T /e) in front of the anode. This paper describes particle and power balances to estimate the bulk plasma potential of a hot-filament discharge plasma produced in a multi-dipole plasma device. The bulk plasma potential dependence on positive DC bias applied to an anode is analyzed, and the predicted characteristics of the plasma potential dependence are compared to the experiment. A steady state potential dip in front of an anode is experimentally observed using emissive probes with the zero emission inflection point method, and the conditions for the potential dip formation are derived.

20933 Dr. strangelove - or, how I learned to stop worrying and love plasma instabilities. Bekefi, G. (Massachusetts Inst. of Tech., Cambridge, MA (USA)). pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184--: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

This paper presents a review of experiments in which different types of instabilities on relativistic electron beams have led to unprecedented levels of coherent electromagnetic radiation.

20934 Voltage - current characteristics of a high current diffuse discharge. Byszewski, W.W. (GTE Labs., Inc., Waltham, MA (USA)). pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184--: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

This paper reports high current density diffuse discharges in high pressure, electronegative gas mixtures studied in an impedance matched transmission line system. A traveling voltage waveform with an amplitude up to 40 kV, a rise time of 2 ns and a total pulse width of 100 ns was used. Gas mixtures of C_3F_8 and He in the pressure range between 100 and 600 Torr were investigated in the uniform field formed by plane parallel electrodes with 10 cm diameter and spacings from 0.25 to 1.5 cm. The objective of this work was to identify the minimum operating voltage and corresponding current density. Although the minimum has not been reached, half the operating voltage at the low current density has been measured in these investigations.

20935 Exploding metal film active anode source experiments on the LION extractor ion diode. Rondeau, G.D. (Cornell Univ., Ithaca, NY (USA). Lab. of Plasma Studies); Bordonaro, G.J.; Greenly, J.B.; Hammer, D.A. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184--: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

In this paper the authors report results using an extractor geometry magnetically insulated ion diode on the 0.5 TW LION accelerator. Experiments with an exploding metal film active anode plasma source (EMFAAPS) have shown that intense beams with significantly improved turn-on time compared to epoxy-filled-groove anodes can be produced. A new geometry, in which a plasma switch is used to provide the current path that explodes the thin film anode, has improved the ion efficiency (to typically 70%) compared with the previous scheme in which an electron collector on the anode provided this current. Leakage electron current is reduced when no collector is used.

20936 Experimental results with an A6 relativistic magnetron. Treado, T.A. (North Carolina State Univ., Raleigh, NC (USA)); Doggett, W.O.; Smith, R.S. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184--: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The A6 magnetron has been studied in the long- and short-pulse regimes at voltages from 0.2 to 0.5 MV. For the first time, finite length cathode effects are included in the frequency characteristics and the voltage - magnetic field behavior of the A6 magnetron operating with a washer cathode. When oscillating in the pi mode, maximum power was emitted near the Hartree threshold condition. When oscillation in the 2 pi mode, maximum power was emitted near the Hartree threshold condition if the cathode radius was effectively reduced as a result of the fringing fields produced by the

axially short washer cathode. The effective cathode radius was found by comparing the operating frequency with resonant frequency calculations. The authors report on an empirical relationship established by us which was used to extend 2-dimensional resonance frequency calculations to account for some 3-dimensional effects. They have observed a linear relationship between the slopes of the cathode to anode length ratio vs. the operating frequency and the slope of the cathode to anode radius ratio vs. the theoretical resonant frequency.

20937 Experimental study of cusp injected electron beam. Boulais, K. (Naval Surface Warfare Center, Silver Spring, MD (USA)); Choe, J.Y.; Namkung, W.; Ayres, V. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184--: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Critical parameters were measured for the axis-encircling electron beam of a cusptron microwave tube for several different magnetic field profiles. The cusptron is a compact and high power microwave tube under development. The tube utilizes the negative mass instability (NMI) of an axis-encircling electron beam either in a circular or multivane circuit. Thus, microwave radiation can be produced at the fundamental or high harmonics of the electron cyclotron frequency. A series of experiments were set up to measure the beam envelope radius and velocity ratio as a function of axial distance for several magnetic field profiles. Each field profile maximized one of the off-centering sources from which measurements were taken. Thus, insight to the magnitude of off-centering and spread in axial velocity for each source led to a final field profile set up to reduce these undesirable effects with successful results. These results are presented with comparison to single particle orbit theory including computer simulations.

20938 Distributions of neutral atoms in pulsed ion diodes measured by optical interferometry and spectroscopy. Kasuya, K. (Tokyo Institute of Technology, Dept. of Energy, Sciences, The Graduate School at Hagatsuta, Nagatsuta 4259, Midori-ku, Yokohama, Kanagawa 227 (JP)); Horioka, K.; Kato, S.; Goino, Y. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184--: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

It is important to make clear the process which occurs in the anode-cathode gap of the intense pulsed ion diode to control the extracted beam quality and to obtain the best operating condition. Two of the most useful diagnostics for this purpose are interferometry and spectroscopy of this kind of diode. In this paper, the authors present results from these kinds of experiments. They used an annular magnetically insulated diode, which was driven by a 5 ohm - 60 ns Blumlein line. Anode ion sources were conventional hydrocarbon waxes (or cryogenic frozen materials in some cases). The applied diode voltage was about 300 KV, and a biased ion collector and a Rogowski coil were used to measure the extracted ion beam current and the diode current.

20939 Particle diffusion in turbulent fields: Transition from quasilinear to nonlinear stage. . Ishihara, O. (Texas Tech Univ., Lubbock, TX (USA). Dept. of Electrical Engineering). pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184--: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Charged particles in random electric fields are known to diffuse over phase velocity resonant layer in velocity space, while charge particles placed in a sheared magnetic field diffuse over the mode rational surfaces due to ExB random fluctuations. The authors study in detail the transition of particle diffusion in turbulent fields from quasilinear (constant diffusion rate) to nonlinear regime (time depend rate) by test particle numerical experiments. They observe that particle diffusion rate is substantially deviated from the quasilinear value and depends on time when the amplitude of random field becomes larger. Such a transition from quasilinear to nonlinear diffusion is observed without particle loss from the resonance region. Time dependence diffusion coefficient may be explained by the effect of retarded friction caused by turbulent fluctuations.

20940 The plasma universe. Peratt, A.L. (Los Alamos National Lab., NM (USA)). pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184--: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

With the advent of the space age, the solar system has become the primary laboratory in which plasma processes of great generality can be studied. Discoveries made from in-situ measurements within the solar system include double layers in the earth's auroral circuit, 5 megaampere magnetic-field aligned currents connecting the satellite Io to Jupiter, and an immense torus of plasma surrounding Saturn and its rings. The extrapolation of observed plasma densities, magnetic and electric field strengths, and energies in near-earth and solar system plasmas to regions beyond the reach of spacecraft has led to the concept of a plasma universe. The evolution of a filamentary plasma universe is reported. Direct comparisons of simulation, laboratory space, and astrophysical data are made.

20941 Collective Thomson scattering in tokamaks having energetic ions. Myer, R.C. (Massachusetts Inst. of Tech., Cambridge, MA (USA). Plasma Fusion Center); Woskov, P.P.; Machuzak, J.S.; Sigmar, D.J.; Cohn, D.R.; Bretz, N.L.; Efthimion, P.C.; Colestock, P.L. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184--: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The authors discuss how collective Thomson scattering (CTS), using high power gyrotrons or long wavelength lasers,m shows promise as a powerful non-intrusive diagnostic of fast-ion transport as it may be capable of measuring the fast-ion velocity distribution and density profile with good spatial and temporal resolution. In addition, CTS may be used as a diagnostic for detecting localized power deposition in the background plasma. High power CTS systems are presently being planned for TFTR, JET, and CIT. Recent theoretical analysis suggests that an energetic (200-800 keV) He^3 minority can be produced in TFTR by ion cyclotron heating (ICH). Such an energetic population would be useful for simulating the energetic alpha-particles produced in a burning plasma. Since the ICH generated distribution is non-Maxwellian, the authors generalize the theoretical analysis of CTS to allow for particle distributions which can be represented by various orthogonal polynomial expansions. They evaluate the efficacy of CTS in detecting a fast He^3 component and determine the sensitivity of the diagnostic to the details of the ion distribution. In particular, the effectiveness of a planned 56 GHz gyrotron CTS diagnostic for TFTR is evaluated.

20942 Application of escape probability to line transfer in laser-produced plasmas. Lee, Y.T. (Lawrence Livermore National Lab., CA (USA)); London, R.A.; Zimmerman, G.B.; Haglestein, P.L. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184--: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

In this paper the authors apply the escape probability method to treat transfer of optically thick lines in laser-produced plasmas in plan-parallel geometry. They investigate the effect of self-absorption on the ionization balance and ion level populations. In addition, they calculate such effect on the laser gains in an exploding foil target heated by an optical laser. Due to the large ion streaming motion in laser-produced plasmas, absorption of an emitted photon occurs only over the length in which the Doppler shift is equal to the line width. They find that the escape probability calculated with the Doppler shift is larger compared to the escape probability for a static plasma. Therefore, the ion streaming motion contributes significantly to the line transfer process in laser-produced plasmas. As

examples, they have applied escape probability to calculate transfer of optically thick lines in both ablating slab and exploding foil targets under irradiation of a high-power optical laser.

20943 X-ray laser based on channel radiation. Rostoker, N. (California Univ., Irvine, CA (USA). Dept. of Physics); Strauss, M. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

A relativistic electron beam propagating through planar or axial channels in a crystal may populate bound transverse energy eigenstates. Spontaneous dipole transitions between these discrete eigenstates lead to narrow width highly polarized X-rays that are strongly forward peaked in intensity. To obtain an observable gain from induced emission the electron beam current density must be 10^7 - 10^8 A/cm^2 for one pass amplification. Several methods to reduce this current density requirement are considered. In this paper, the authors consider several methods to accelerate the beam and to increase the current without increasing the transverse energy of the beam by using a pulsed source. Heating or crystal damage by the beam is evaluated.

20944 High-energy photon spectra from a tungsten plasma flow switch experiment. Davis, J.F. (Washington Research Center, Alexandria, VA (USA)); Coffey, S.K.; Degnan, J.H.; Price, D.W. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The authors report an array of silicon diodes with appropriate K-edge filters used to determine the high-energy (6 - 500 keV) photon spectra of a high temperature tungsten plasma using a 4.6 MJ, 83kV plasma flow switch. The detector array used 10 different filter material/thickness combinations. The observed x-ray emission had a duration of > 600 nanoseconds (FWHM of 350 ns) with the peak x-ray power occurring approximately 250 ns after the peak of the voltage spike. The x-ray spectra deconvolved from observed detector signal indicated a peak power of approximately 325 MW above 8 keV with a peak plasma temperature of 46 keV from an exponential fit to the spectra about 20 keV.

20945 Infrared atmospheric oxygen plasma emission spectra as a diagnostic tool. Alexiou, S. (Brown Univ., Providence, RI (USA)). pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Plasma-broadened visible spectra have long been used to infer plasma parameters. With the development of longer wavelength detector technology and the improvement of computational capabilities infrared spectra are a very promising probe since because of their greater sensitivity very accurate determination of plasma parameters is possible. This paper presents a study in which infrared spectra of oxygen in the region 5 - 8μ were modelled for a temperature around 10000^{0}K and densities of 10^{14} - 10^{16} e/cc. The spectra are seen to very sensitive to the plasma density.

20946 Characterization of a multipolar electron cyclotron resonance microwave plasma source. Hopwood, J. (Michigan State Univ., East Lansing, MI (USA)); Wagner, R.; Reinhard, D.K.; Asmusen, J. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

A microwave cavity plasma applicator with multicusp electron cyclotron resonance (ECR) is demonstrated as an ion beam source, and for the oxidation and etching of semiconductor materials. In an effort to better understand and optimize these processes, the authors characterize this plasma reactor over its range of operating conditions. Single and double Langmuir probe measurements of electron density, ion density, and electron energy distribution functions have been determined spatially in the downstream region and as a function of power (120W-250W) and pressure (0.5-15 mtorr) in argon and oxygen. In addition, Faraday cup measurement of ion energies and optical emission data are presented.

20947 Measurements of the plasma temperature associated with the interactions of high power pulse lasers with the materials. Hong-Young, C. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Investigations of the plasma parameters associated with plasma production by laser radiation of very high intensity are examined. In the experiment, 50 nsec, 5J Nd-glass laser pulses were focused onto plane targets of solid steel, aluminum, etc. Expansion speed and size measurement of the plasma were performed. The electron temperature of the plasma were determined from the absorption measurements through the plasma, the continuum radiation measurement, and the direct measurement of the radiation power in a finite frequency range. Building up and decay of the plasma density were determined by interferometric techniques.

20948 Microwave reflectivities of a finite-length plasma with a periodic density variation. Figueroa, H. (University of Southern California, Los Angeles, CA (USA). Dept. of Electrical Engineering); Gundersen, M.A.; Joshi, C. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Infinitely long plasmas with periodic density variations have been reported to present forbidden bands of frequencies in both the plasma wave and electro-magnetic wave dispersion relations. These forbidden bands are the result of constructive Bragg reflections from the various plasma layers one period apart. In this paper the authors discuss the possibility of using such forbidden bands of frequencies to design efficient microwave plasma mirrors of variable reflectivity. A possible design is proposed and the range of reflectivities is discussed.

20949 Modeling of the discharge plasma in a back lighted thyratron. Bauer, H. (University of Southern California, Los Angeles, CA (USA). Dept. of Electrical Engineering); Kirkman, G.; Gundersen, M.A. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The population of atomic levels in a back lighted thyratron (BLT) plasma with electron density of 1-5 10^{15}cm^{-3} and current density of about 10^4 A/cm^2 is calculated and line intensity ratios are compared with spectroscopic measurements. Simple considerations lead to a very small cathode fall width during the conduction phase and the resulting high electric field can create fast electrons with energies of some 100 eV. From a solution of the Fokker-Planck equation it ws found that fast electrons can penetrate the gap region consisting of a Maxwellian plasma with electron density of 10^{15}cm^{-3} and electron temperature of 1-2 eV. The BLT plasma was modeled assuming a monoenergetic electron beam with a strong anisotropic velocity distribution function, which penetrates a low electric field region of a bulk plasma at thermal equilibrium and neutrals.

20950 A transmission line theory of surface flashover arcs. Kadish, A. (Los Alamos National Lab., NM (USA)); Maier, W.B.; Robiscoe, R.T. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The dynamics of flashover arc discharges is studied using a transmission line model in which the resistance per unit length, R, and the current, I, are assumed to satisfy the local arc welder's ansatz R absolute value of I = E* where E* is a constant having

the dimensions of an electric field. The model predicts a local threshold condition for onset of current flow. The model also predicts abrupt termination of arc current in some parts of the transmission line while other parts continue to remain active. In general, passive regions where current flow has terminated remain electrically charged. Current in the active regions may either quench or generate restart of current in a neighboring passive region. The general dynamics of abrupt termination and restart are discussed. Examples are presented.

20951 Gain calculations for L-shell x-ray lasers. Kyrala, G.A. (Los Alamos National Lab., NM (USA). Physics Div.). pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Intense short pulse lasers that may be focused to irradiances exceeding 10^{20} W/cm^2 are becoming readily available. Laser matter interactions at these intensities generate intense short x-ray pulses in the keV photon energy range with radiances of a few 10^{16} W/cm^2. Schemes that use these x-ray pulses to pump inner and outer shell laboratory x-ray lasers are nearer to reality. In this paper the author presents calculations for the threshold x-ray pump irradiance that is required to cause steady state inversion in the L-M manifold for materials with $11<Z<31$. An arrangement for an aluminum L-M shell laser pumped by the x-rays from a laser produced silicon plasma is presented.

20952 Numerical mode and boundary analysis of bifurcation phenomena in plasmas with stationary striations. Papavaritis, P. (Univ. of Miami, Dept. of Physics (US)); Pardo, W.B. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

A non-linear phenomenon occurring in radio-frequency-excited inert gas plasmas with zero d.c. magnetic field results in the formation in the plasmas of stationary striations induced by the onset of an instability. This instability has theoretically been found to depend on various bifurcation parameters which can be experimentally controlled. Some experimental results have been obtained and compared with theory. Striations have been observed in neon and argon under a wide range of operating conditions. Transitions between modes caused by changes in the length, power or pressure exhibit hysteresis. The hysteresis in some parameter regions appears to be due, at least in part, to the flexibility of the boundary. Criteria are proposed for the automatic localization of the plasma boundaries. A computer program has been written for the application of the same to digitized experimental runs and for the analysis of corresponding plasma modes. The results of the analysis of several cases of particular interest are presented, and comparisons are made with theory.

20953 Operation of a double cavity, microwave pulse compression system with phase controlled output. Bolton, P.R. (Lawrence Livermore National Lab., CA (USA)); Alvarez, R.A. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). DOE Contract W-7405-ENG-48. (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Ultra-short microwave pulses of high peak power are generated by switching the impedance of a high Q S band microwave cavity. For a given cavity rapid closure of a gaseous plasma switch as a result of localized electron density growth enhances the coupling of the output port while greatly reducing that of the input port. A series of homodyne measurements using fast solid state mixers have demonstrated the existence of a constant phase relationship between input pulses (typically 1 microsecond FWHM) and output pulses (typically 4 nanoseconds FWHM). The authors have therefore constructed a double cavity system designed for simultaneous parallel operation of both microwave cavities with input phase control on one. Both cavities are filled by splitting equally a single incident pulse from a klystron tube. The independent tuning of each cavity to the same resonant frequency for optimum energy storage is achieved by small variations in the SF_6 pressure. Characteristics of the double cavity system performance and tuning, as well as future developments such as the use of a laser-induced gaseous switch are presented.

20954 Laser diagnostic studies of particulate contamination generated by etching plasmas. Selwyn, G.S. (International Business Machines Corp., Yorktown Heights, NY (USA). Thomas J. Watson Research Center). pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Laser light scattering may be used as an in-situ probe of particulate contamination. Using this technique, it is shown that certain silicon etching plasmas can produce significant amounts of particulate contamination. In addition, using spatially-resolved measurements it is shown that most particles are suspended at the sheath boundaries, a finding attributed to electrostatic charging. Further evidence for this unexpected result is provided by simultaneous space and time measurement of laser light scattering with measurement of plasma negative ions. Spatially-resolved measurement of plasma negative ions is possible using a two-photon laser-induced fluorescence technique (LIF). The parametric conditions favorable for particle formation and growth are identified. Generation of particles is seen to be strongly affected by the choice of process feedgas, flow rate, pressure and the presence and exposed area of the etch substrate. Comparison of light scattering measurements with negative ion LIF measurements, suggests the involvement of plasma negative ions in the formation of particles. A mechanism for nucleation and growth is discussed. Comparison is made of laboratory light scattering measurements with wafer spot counts obtained under manufacturing conditions. Implications for dry process technology are discussed.

20955 The pitch angle detector: Pade. . Leal-Quiros, E. (Missouri Univ., Columbia, MO (USA). Dept. of Nuclear Engineering); Prelas, M.A. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The authors describe Pade, a new analyzer that can measure the pitch angle of electrons or ions, with respect to the magnetic field in a magnetized plasma. This device is formed by two directional energy analyzers, mutually perpendicular to one another. Both miniature directional energy analyzers of 4mm of diameter are in the same small case and are very close each other. This fact allows properties to be measured at the same point in the plasma region such as average kinetic energy, perpendicular and parallel to the magnetic field. From this data the pitch angle can be measured.

20956 Theory for beam-plasma millimeter-wave radiation source experiments. Rosenberg, M. (Rosenberg Consultants, San Diego, CA (US)); Krall, N.A. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

This paper reports on theoretical studies for millimeter-wave plasma source experiments. In the device, millimeter-wave radiation is generated in a plasma-filled waveguide driven by counter-streaming electron beams. The beams excite electron plasma waves which couple to produce radiation at twice the plasma frequency. Physics topics relevant to the high electron beam current regime are discussed.

20957 Simple reflection in an ionizing gas cloud. Rappaport, H.L. (Maryland Univ., College Park, MD (USA)); Latham, P.E.; Striffler, C.D. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

In this paper, the authors apply mode conversion theory to 1-dimensional reflection in a time-varying inhomogenous plasma and present numerical results. Degenerate mode conversion, i.e. mode conversion between two eigenvectors of a plasma dispersion tensor with the same eigenvalue, may be analyzed using the same techniques as nondegenerate mode conversion by adding several Maxwell-Two Fluid unknowns and equations into an initial description of the problem. They apply this procedure to simple reflection in a slowly varying plasma with no magnetic field. Results for different cases, i.e. above and below the plasma critical density, are presented. The application to microwave breakdown in the atmosphere is discussed.

20958 Study of the luminescence from infrared window materials undergoing pulsed nuclear irradiation. Barnouin, O. (Illinois Univ., Urbana, IL (USA). Fusion Studies Lab.); Chung, H.; Miley, G.H. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184--: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Pulsed nuclear irradiation of infrared window materials was performed at the TRIGA nuclear reactor of the University of Illinois. The pulse was 17 ms (FWHM) in duration and the 0.1 Mrad dose consisted of 5% of neutrons and 95% of gamma rays. The samples under study included sapphire, CsI, ALON and spinel. The goal of the experiment was to record and analyze the radioluminescence exhibited by these samples during the irradiation. The principal features of the luminescence of the materials studied are presented and a kinetic model for radioluminescence is developed from these results.

20959 High repetition rate, wide bandpass, data acquisition system for high power microwave applications. Miner, L.M. (Beam Physics Branch, Advanced Technology Div., Air Force Weapons Lab., Kirtland AFB, NM (US)); Voss, D.E.; Prerea, P.R. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184--: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The advent of multi-Hz rep-rated pulsed power supplies for high power microwave (HPM) source development and effects testing places severe demands on diagnostic systems. One to two dozen signals with pulse durations ranging from 10s of nanoseconds to 2 microseconds and repetition rates from single-shot to multi-Hz, must typically be recorded with bandpasses exceeding 1 GHz in order to fully characterize source operation. Recent advances in instrumentation allow a single VAX 8650 to control and archive a fully automated, digital data acquisition system utilizing a multiplicity of data recording devices. The authors describe the system architecture, digitizing hardware, data capture and archiving software, as well as the networking of the system for transient signal capture and analysis.

20960 Probe technique for direct measurement of temporal variation of electron temperature. Wendt, A. (Wisconsin Univ., Madison, WI (USA)); Hershkowitz, N. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184--: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

This work is an examination of a technique proposed for making direct measurements of electron temperature oscillations in a plasma. The technique employs the relationship between the floating potential and the plasma potential for a Maxwellian distribution of electrons with temperature. The plasma potential and floating potential oscillations are measured directly, and the temperature oscillation is inferred through this relationship. Results are presented evaluating the potential of this technique over a variety of plasma conditions, including an rf reactive ion etching environment. Measurements are presented over a range of pressures, plasma densities and hot-filament bias voltages, and use of the technique in the presence of non-maxwellian electron distributions is addressed.

20961 Plasma emission and absorption spectroscopy with an optical fiber probe. Jin, Z.J. (Center for Electromagnetic Research and Dept. of Electrical and Computer Engineering, Northeastern Univ., Boston, MA (US)); Chan, C. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184--: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The authors describe the use of an optical fiber probe for measuring the emission and absorption coefficients of a parallel-plate rf plasma. The optical fiber probe is made of crofon and inserted into a glass tube filled with air at atmospheric pressure in order to prevent the initiation of a discharge by the rf capacitively coupled inside the tube. The probe end of the glass tube is designed as a half-lens for focusing. The advantage of the optical fiber probe is this capability to make localized measurements. As a result, three-dimensional mapping of emission and absorption properties of plasma can readily be made.

20962 Spatially resolved plasma emission and absorption coefficient measurements by an optical fiber probe. Jin, Z.J. (Northeastern Univ., Center for Electromagnetics Research, Dept. of Electrical and Computer Engineering, Boston, MA (US)); Chan, C. *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Plasma Science (USA)*, 17(6): 870-874 (Dec 1989).

Using an optical fiber probe in a parallel-plate RF glow discharge, the authors have measured the plasma emission and absorption coefficients with two different techniques. The first technique can, in principle, provide three-dimensional resolution with the movement of the probe, while the second technique provides only a line-average measurement. The results of two different measuring methods and the practical limitations of the techniques are discussed.

20963 Analytic expression for the electric potential in the plasma sheath. Sheridan, T.E. Jr. (Iowa Univ., Iowa City, IA (USA). Dept. of Physics and Astronomy); Goree, J.A. *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Plasma Science (USA)*, 17(6): 884-888 (Dec 1989).

An expression for the spatial dependence of the electric potential in a collisionless and source-free planar plasma sheath is presented. This expression is derived in analogy with Child's law and approaches Child's law asymptotically as the potential drop across the sheath becomes large. A comparison with numerical solutions of the model equations is discussed.

20964 Recovery properties of vacuum spark gaps. Sampayan, S.E. (Lawrence Livermore National Lab., CA (USA)); Gurbaxani, S.H.; Buttram, M.T. *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Plasma Science (USA)*, 17(6): 889-897 (Dec 1989).

Multi-kilohertz vacuum spark gap switching utilizing diffuse discharge and counter-pulse techniques has recently been demonstrated. In addition, commercial, high coulomb vacuum interrupter switches have shown free recovery rates greater than 10 kV /μs. Thus, vacuum spark gap switches may provide an alternative method of high average power switching. The authors have investigated the recovery properties of a 90 kV, 15 kA multiple site, triggered vacuum spark gap. Triggering was accomplished with a multisite surface flashover plasma source with approximately 60 sites distributed over a 10 cm^2 area. Gap dimensions were 1-cm spacing by 7.5-cm diam. Recovery measurements are presented and discussed.

20965 Pulsed cathode heating method. Lipscomb, G.A. (U.S. Naval Jet Pilot School, Meridan, MS (US)); Herniter, M.E.; Getty, W.D. *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Plasma Science (USA)*, 17(6): 898-905 (Dec 1989).

One drawback in the use of lanthanum hexaboride thermionic cathodes at high current density is the amount of steady-state heating power needed to heat the cathode to the desired temperature range (≈1800^{0}C). With continuous heating, approximately 1000 W of power are required to keep a 1-in diam cathode at 1800^{0}C. For 2-in diam cathodes, the power requirement rises to 3 to 5 kW. Cathode evaporation is significant with continuous heating

at 1800°C. To reduce the average power requirement and evaporation in pulsed experiments, a transient heating scheme has been investigated which allows single shot or slow, cyclic heating of the cathode. This scheme gives a few seconds of peak temperature during which microsecond-length beam pulses can be fired with a suitable pulse modulator. In this paper, the authors present calculations based on a thermal model with electron bombardment heating, and compare these calculations with a pulsed-heating experiment.

20966 **Frequency-tunable, high-power microwave emission from cyclotron autoresonance maser oscillation and gyrotron interactions.** Wang, J.G. (Michigan Univ., Ann Arbor, MI (USA). Dept. of Nuclear Engineering); Gilgenbach, R.M.; Choi, J.J.; Outten, C.A.; Spencer, T.A. *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Plasma Science (USA),* 17(6): 906-908 (Dec 1989).

The authors report experimental observations of high-power microwave emission from both the high-frequency cyclotron autoresonance maser (CARM) oscillation and the low-frequency gyrotron interaction. High-power (3-10 MW) microwave emission is attributed to the CARM mechanism, which is magnetically tunable through discrete axial cavity modes from 15 through 16.7 GHz. For the same experimental parameters, megawatt level microwave emission is observed, which is magnetically tunable from 10 through 14 GHz, indicating low-frequency gyrotron oscillation. High-frequency microwave pulse-lengths of up to 0.2 μs have been generated, which is a factor of five greater than previous CARM experiments.

20967 **Solving the spatially dependent Boltzmann's equation for the electron-velocity distribution using flux corrected transport.** DiCarlo, J.V. (University of Illinois, Department of Electrical and Computer Engineering, Gaseous Electronics Laboratory, 607 East Healey, Champaign, Illinois 61820 (US)); Kushner, M.J. *Journal of Applied Physics (USA),* 66(12): 5763-5774 (15 Dec 1989).

Boltzmann's equation(BE) for the electron-velocity distribution (EVD) in partially ionized plasmas is not usually directly integrated as an initial value problem using finite differences. This circumstance is a result of numerical effects which blur sharp density boundaries in the position-velocity plane. To address this issue, we have applied flux corrected transport (FCT) to solving BE and demonstrated the method by calculating the EVD in the cathode fall of a He glow discharge by direct integration. Unidirectional and bidirectional EVDs are considered, and comparisons are made to conventional multibeam and Monte Carlo simulations to validate our method. We find that using FCT to solve BE is a significant improvement over conventional finite difference methods, being both more accurate and computationally faster.

20968 **Measurement of the quenching of spontaneous emission coefficients in laser-produced plasmas.** Chung, Y. (Princeton Plasma Physics Laboratory, P.O. Box 451, Princeton, New Jersey 08543 (USA)); Hirose, H.; Suckewer, S. *Physical Review [Section] A: General Physics (USA),* 40(12): 7142-7149 (15 Dec 1989).

The quenching of Einstein *A* coefficients was observed by measuring the branching ratio of visible and extreme-ultraviolet line intensities for C IV, C III, and N V ions.

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Refer also to citation(s) 20149, 20150, 20161, 20162, 20174, 20195, 20196, 20605, 20606, 20614, 20881, 20921, 20924, 20925, 20926, 20927, 20928, 20929, 20930, 20931, 20934, 20937, 20940, 20941, 20944, 20945, 20949, 20950, 20952, 20956, 20965, 20966

20969 (CONF-891240–6) **The ANU [Australian National University] Heliac Program.** Dewar, R.L.; Gardner, H.J.; Cooper, G.J.; Hamberger, S.M.; Sharp, L.E.; Blackwell, B.D.; Tou, T.Y.; Conway, G.D.; Shi, X.H.; Zhou, D.F. Oak Ridge National Lab., TN (USA). [1989]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From First international Toki conference on plasma physics and controlled nuclear fusion; Toki (Japan); 4-8 Dec 1989. Order Number DE90006620. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The history and current status of experimental and theoretical work on heliacs at the Australian National University are reviewed. 18 refs., 1 fig., 1 tab.

20970 (CONF-900403–1) **Evaluation of radiation-induced sensitization using electrochemical potentiokinetic reactivation technique for austenitic stainless steels.** Inazumi, T. (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan)); Bell, G.E.C.; Hishinuma, A. Oak Ridge National Lab., TN (USA). [1990]. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Corrosion '90; Las Vegas, NV (USA); 23-27 Apr 1990. Order Number DE90002708. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The electrochemical potentiokinetic reactivation (EPR) test technique was applied to the determination of sensitization in a neutron-irradiated (420°C, 10 dpa) titanium-modified austenitic stainless steel. Miniaturized specimens (3 mm diam by 0.25 mm thick) in solution-annealed and 25% cold-worked conditions were tested. The degree of sensitization (DOS) was calculated in terms of the reactivation charge (Pa). Results indicated the occurrence of radiation-induced sensitization when compared to control specimens thermally aged at the irradiation temperature. Post-EPR examination of the specimen surfaces showed etching across the face of each grain as well as at grain boundaries. This indicates that the Pa value normalized by the total grain boundary area, which is an accepted EPR-DOS criterion, cannot be directly used as an indicator of the DOS to determine the susceptibility of this irradiated material to intergranular stress corrosion cracking (IGSCC). Further investigations are necessary to correlate the results in this study to the IGSCC susceptibility of the irradiated stainless steel. 26 refs., 7 figs., 3 tabs.

20971 (CONF-900418–1) **Convergence properties of iterative algorithms for solving the nodal diffusion equations.** Azmy, Y.Y.; Kirk, B.L. Oak Ridge National Lab., TN (USA). [1990]. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From International conference on the physics of reactors: operation, design and computation; Marseilles (France); 23-26 Apr 1990. Order Number DE89016859. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We drive the five point form of the nodal diffusion equations in two-dimensional Cartesian geometry and develop three iterative schemes to solve the discrete-variable equations: the unaccelerated, partial Successive Over Relaxation (SOR), and the full SOR methods. By decomposing the iteration error into its Fourier modes, we determine the spectral radius of each method for infinite medium, uniform model problems, and for the unaccelerated and partial SOR methods for finite medium, uniform model problems. Also for the two variants of the SOR method we determine the optimal relaxation factor that results in the smallest number of iterations required for convergence. Our results indicate that the number of iterations for the unaccelerated and partial SOR methods is second order in the number of nodes per dimension, while, for the full SOR this behavior is first order, resulting in much faster convergence for very large problems. We successfully verify the results of the spectral analysis against those of numerical experiments, and we show that for the full SOR method the linear dependence of the number of iterations on the number of nodes per dimension is relatively insensitive to the value of the relaxation parameter, and that it remains linear even for heterogenous problems. 14 refs., 1 fig.

20972 (DOE/DP/10684–1) **Experimental study of population inversion and spectral line broadening in a plasma containing a mixture of high Z and low Z ions: Final technical report, 8 April 1987–18 October 1988.** Griem, H.R. Maryland Univ., College Park, MD (USA). Lab. for Plasma Research. Oct 1988. 42p. Sponsored by U.S. DOE Defense Programs. DOE Contract AS08-87DP10684. Order Number DE90007552. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In our work this past year at the University of Rochester's Laboratory for Laser Energetics we have studied laser-produced plasmas using spherical targets continuing layers of high Z and low Z materials. Our emphasis was on quantitative spectroscopy of ions in a very dense, recombining plasma. The targets used consisted of carbon-copper, carbon-gold, and aluminum-gold mixtures, instead of the originally proposed Fe or Mo mixtures with carbon.

The thickness of the Cu and the Au layers were varied in order to study the effect of higher Z ions cooling the plasma. Indeed a pronounced cooling effect was observed by increasing the thickness of the Au layer in targets with Al-Au layers. Electron temperatures were studied by measuring the 1s-2p/$1s^2$-1s2p line ratio of Al XIII to Al XII. Our experimental measurements, together with a collisional-radiative model and a 1-D hydrodynamic code, indicate that the electron temperature falls from 1500 eV with no gold to 950 eV with a 500 Å layer of gold. A detailed discussion of our results with Al-Au targets can be found in the enclosed preprint entitled Radiation Cooling in Laser-Produced Plasmas Due to High-Z Layers.

20973 (DOE/DP/40200–113) **Effect of barrier layers in burn-through experiments with 351-nm laser illumination.** Delettrez, J.; Bradley, D.K.; Jaanimagi, P.A.; Verdon, C.P. Rochester Univ., NY (USA). Lab. for Laser Energetics. Feb 1990. 42p. Sponsored by U.S. DOE Defense Programs; Empire State Electric Energy Research Corporation; New York State Energy Research and Development Authority; Ontario Hydro; Rochester University. DOE Contract FC03-85DP40200. Order Number DE90006806. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The time-resolved x-ray emission is measured from spherical targets consisting of glass shells overcoated with plastic in which thin signature layers are embedded. These targets are illuminated at 351 nm by the 24-beam OMEGA laser system at the Laboratory for Laser Energetics of the University of Rochester. We measure a large burn- through rate for bare plastic targets, which can only be replicated in 1-D hydrodynamic simulations with laser intensities in excess of ten times the nominal intensity. We observe that the burn-through times are affected by the presence of a thin outer coating (barrier layer). The burn-through times depend strongly on the barrier-layer material and thickness, whereas one-dimensional simulation results predict only a small effect. Several processes are considered to explain these results: illumination nonuniformity, early shine-through of the laser light through the plastic, prepulses, filamentation, self-focussing of hot spots, and the Rayleigh-Taylor instability. We conclude that mixing due to the Rayleigh-Taylor instability, enhanced by early shine-through, is the most probable cause of the observed large burn-through rates. 27 refs., 8 figs., 1 tab.

20974 (EGG-CS–8821) **Neutron monitoring measurements for the CIT [Compact Ignition Tokamak] materials irradiations in the ATR I1 position.** Rogers, J.W.; Anderl, R.A. EG and G Idaho, Inc., Idaho Falls, ID (USA). Dec 1989. 24p. Sponsored by U.S. DOE Energy Research. DOE Contract AC07-76ID01570. Order Number DE90006964. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Measurements were performed to help characterize the neutron environments in which the Compact Ignition Tokamak (CIT) materials were irradiated. These materials were irradiated in a lead shield plug assembly at the ATR I1 position. Neutron monitor materials were placed in the capsules in proximity with the CIT specimens. The neutron monitors sensed the neutrons through reactions that have different neutron energy region responses. By measuring the radioactivity of the neutron monitors it was possible to determine the neutron fluence rates (n/cm^2/sec) and fluences (n/cm^2) at the locations of the monitors. It was also possible to determine the axial and radial gradients of the neutron environments near the specimens. This report presents the results obtained from these measurements for both the CIT #1 (ORNL 64-2) and CIT #2 (ORNL 64-1) capsules. In general, ASTM methods and procedures were used in all neutron monitoring associated activities. 7 refs., 9 figs., 10 tabs.

20975 (EGG-FSP–8653) **Safety and environmental issues of HYLIFE-II.** Dolan, T.J.; Longhurst, G.R. EG and G Idaho, Inc., Idaho Falls, ID (USA). Oct 1989. 36p. Sponsored by U.S. DOE Energy Research. DOE Contract AC07-76ID01570. Order Number DE90006966. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Safety goals for HYLIFE-II include a routine tritium release rate < 40 Ci/day and the consequences of a severe accident to result in no acute offsite fatalities. Equations are developed describing tritium flows in the primary and intermediate coolant loops. Approximate tritium release rates and inventories are estimated using rough estimates of the transfer fractions in the heat exchangers and stripping chambers, but the transfer fractions need to be better quantified before accurate estimates can be made. The consequences of a severe accident involving blast chamber failure and breach of the containment building are investigated. It is found that offsite radiation doses would produce no acute fatalities. However, according to this preliminary analysis, beryllium concentrations in the air at the site boundary could exceed Federal standards. The N-stamp issue, maintenance, and waste material management are discussed briefly. 23 refs., 6 figs., 5 tabs.

20976 (EGG-FSP–8742) **Development of the passive safety concept and its application to ITER [International Thermonuclear Experimental Reactor].** Brereton, S.J.; Holland, D.F.; Piet, S.J. EG and G Idaho, Inc., Idaho Falls, ID (USA). Nov 1989. 48p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90007040. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Since the start of the ITER design effort, safety experts have attempted to guide designers in the development of a machine that will demonstrate the potential safety and environmental advantages of fusion. Offsite dose limits, based on regulatory requirements, have been translated into release rates or radiological inventories, which provide useful guidance to designers. The ITER team is attempting to protect the public from major accidental releases to the extent possible in a passive manner, that is, without relying on active systems. The concept of passive safety is developed here by the US safety times for internal events and for external events that are within the envelope of design basis accidents selected for ITER. In addition to overall safety guidance, implications of passive safety for ITER systems, as envisioned by the US safety team, are discussed. An approach to implementing passive safety in ITER, with reference to the blanket, plasma facing components, fuel cycle systems, plasma shutdown, magnet design, the testing program, and maintenance is described. The need for a confinement building is addressed, and the role of such a building in the context of passive safety is discussed. 16 refs., 4 figs., 6 tabs.

20977 (EGG-FSP–8766) **Observing diffusivity and traps for tritium in metals by thermal transient tests.** Longhurst, G.R. EG and G Idaho, Inc., Idaho Falls, ID (USA). Oct 1989. 21p. Sponsored by U.S. DOE Energy Research. DOE Contract AC07-76ID01570. Order Number DE90007014. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

It is of great interest to fusion designers and analysts to know in some detail the permeation and trapping characteristics of various metals for tritium. Specific parameters sought include diffusivity, diffusion activation energy, solubility, enthalpy of solution, tritium trap density and trapping energies. One way of looking for this information is to subject samples of the material containing tritium to thermal transients and measure the amount of tritium that is absorbed or released from the samples. In this report various factors that influence the observability of the parameters of interest and suggestions for structuring the tests are discussed. Samples for testing may be arbitrary in shape, but analysis is easiest on samples which may be treated as one-dimensional such as thin plates or long cylindrical rods or spheres. Most of the analysis presented here assumes simple thin, flat plate geometry for convenience. While second-order effects may vary between the various geometries, the fundamental results will be the same for all geometries. 4 refs., 6 figs., 1 tab.

20978 (EGG-M–89020) **Preliminary examination of accident scenarios for the aqueous salt blanket.** Brereton, S.J. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 63p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC07-76ID01570. (CONF-8902162–1: Aqueous lithium salt blanket workshop, Toronto (Canada), 7-9 Feb 1989). Order Number DE90006951. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The aqueous salt blanket for ITER (International Thermonuclear Experimental Reactor) has been examined with regards to accident safety. Source terms include tritium as well as dissolved and deposited activated corrosion products in the breeder salt solution and in the water coolant. Scenarios investigated in detail include a pipe break within a breeder module and a major loss of coolant accident (LOCA). The impact of varying the salt concentration in the

breeder solution and of operating the salt at a lower pressure on the accident consequences was examined. Consequences of the pipe break were found to be dependent on the duration of flow after the break and the amount of spilled material that becomes airborne. 26 refs., 4 figs., 10 tabs.

20979 (EGG-M–89205) **Safety analysis of the Compact Ignition Tokamak (CIT) release of activated solid material.** Lyon, R.E.; Holland, D.F. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC07-76ID01570. (CONF-891007–117: 13. IEEE symposium on fusion engineering, Knoxville, TN (USA), 2-6 Oct 1989). Order Number DE90007041. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Recent safety studies for the Compact Ignition Tokamak (CIT) have addressed the potential risk associated with the release of activated solid materials from sources such as the vacuum vessel and the TF coils, including insulation, as a result of off-normal events associated with the machine. A number of initiating events have been identified that could lead to mobilization of the activated material and the maximum quantities that could be mobilized have been estimated. These events include: a gas break into the torus releasing tokamak dust, plasma disruptions vaporizing first wall material, graphite combustion volatilizing activated structural material, and magnet arcs volatilizing magnet or torus material. Several operating scenarios, both bounding and realistic, have been investigated to determine a spectrum of isotope concentrations which might be present in the materials. Source terms for the various release scenarios are established using this information. The various release modes are identified along with factors which could reduce the amounts of activated material actually released. From this information, the doses resulting from a spectrum of releases are presented and discussed. A number of factors, identified in the paper, lead to the conclusion that accidental release of activated solids does not present a significant public risk from the operation of CIT. 11 refs., 2 tabs.

20980 (EGG-PHY–8784) **The INEL beryllium multiplication experiment annual report FY89.** Smith, J.R.; King, J.J. EG and G Idaho, Inc., Idaho Falls, ID (USA). Dec 1989. 23p. Sponsored by U.S. DOE Energy Research. DOE Contract AC07-76ID01570. Order Number DE90006973. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This is a report of activities during the second year of a three-year program to measure the multiplication of 14-MeV neutrons in bulk beryllium. The operating parameters of the neutron generator were established. The manganese sulfate solution was chemically characterized. A ^{252}Cf neutron source was acquired for use in studying the systematics of the experimental setup. Measurements were made of the multiplication of neutrons in beryllium, using both 14-MeV neutrons and the ^{252}Cf source. Uncorrected multiplication values for the 14-MeV neutrons are 2.110, 1.927, and 1.388 for the 19.9 cm, 12.1 cm, and 4.6 cm beryllium thicknesses, respectively. A preliminary Monte Carlo calculation, using MCNP, predicts a value of 2.125 for the uncorrected value of neutron multiplication for the 19.9 cm sample in the manganese bath. The ratio of calculation to experiment is 1.007, supporting the validity of the microscopic cross section files. 13 refs., 4 figs., 3 tabs.

20981 (ETEC–89-4) **Experimental results on frost as a first wall shielding concept for inertial confinement fusion: Final report.** Neely, H.H.; Hoffman, N.J.; Murray, K.A. Rockwell International Corp., Canoga Park, CA (USA). Energy Technology Engineering Center. 1 Mar 1990. 100p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC03-76SF00700. Order Number DE90006341. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

An experimental effort was undertaken at the Energy Technology Engineering Center in support of the design of the Laboratory Microfusion Facility (LMF) by Lawrence Livermore National Laboratory. The purpose of the experiments was to determine the ability of a frost-covered wall to act as a first wall in the LMF for the absorption of x-rays and debris. Certain aspects of the frost shielding concept were verified including growth rate, thermal conductivity, crush strength, ability to absorb shock waves and withstand vibration, and integrity after growth. The experimental results indicate that frost would function as a suitable first wall for the LMF. 87 figs.

20982 (EUR-CEA-FC–1362, pp. 21-24) **Neutral confinement in pump limiter with a throat.** Ghendrih, P. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 -Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee); Grosman, A.; Samain, A.; Capes, H.; Morera, J.P. Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. 1989. (CONF-890302–: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *EURATOM-CEA Association Contributions to the 16. European Conference on Controlled Fusion and Plasma Physics.* Order Number DE90752562. Available from NTIS (US Sales Only), PC A05/MF A01.

The efficiency optimization of the pump limiters is investigated. They are applied in quasi-steady tokamak operations, in which the active control of recycling is achieved by pumping a fraction of the plasma outflux. The particle collection can be improved by means of the throat leading from the nozzle to the neutralizer plate. The amount of escaping neutrals owing to plasma-neutral-sidewall interaction is reduced. The characteristic lengths of this effect, and the neutral density build-up of pump limiters with a long throat (for a large ratio length L over the transverse dimension a), are computed. It is shown that pump limiters, with a long throat, can be operated in the plugging regime. The neutral density build-up is enhanced. The efficiency of the apparatus can be increased in cold and dense edge plasmas.

20983 (IAEA-TECDOC–534, pp. 239-246) **Pneumatic pellet injector research at ORNL.** Milora, S.L. (Oak Ridge National Lab., TN (USA)); Combs, S.K.; Foster, C.A. International Atomic Energy Agency, Vienna (Austria). Dec 1989. Contract DE-AC05-84OR21400. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.* Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

Advanced pneumatic-injector-based pellet fueling systems are under development at Oak Ridge National Laboratory (ORNL) for fueling magnetically confined plasmas. The general approach is that of producing and accelerating frozen hydrogen isotope pellets at speeds in the range from 1 to 2 km/s and higher. Recently, ORNL provided pneumatic-based pellet fueling systems for the Tokamak Fusion Test Reactor (TFTR) and the Joint European Torus (JET), and a new simplified eight-shot injector has been developed for use on the Princeton Beta Experiment (PBX) and the Advanced Toroidal Facility (ATF). These long-pulse devices operate reliably at up to 1.5 km/s with pellet sizes ranging between 1 and 6 mm. In addition to these activities, ORNL is pursuing advanced technologies such as the electrothermal gun and the two-stage light-gas gun to achieve pellet velocities significantly in excess of 2 km/s and is carrying out a tritium proof-of-principle (TPOP) experiment in which the fabrication and acceleration of tritium pellets to 1.4 km/s were recently demonstrated. (author). 27 refs, 10 figs.

20984 (IAEA-TECDOC–534, pp. 247-253) **The JET multi-pellet injector and its future upgrades.** Kupschus, P. (Commission of the European Communities, Abingdon (UK). JET Joint Undertaking); Sonnenberg, K.; Bailey, W. International Atomic Energy Agency, Vienna (Austria). Dec 1989. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.* Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

The present multi-pellet injector operating on JET is equipped with three repetitive pneumatic guns for three different pellet sizes capable of pellet speeds to 1.5 kms^{-1}. It has now been operated for more than one year according to its specification, satisfactorily and successfully, and only minor improvements have been made

during that time. The best plasma performance in its application has so far been achieved with pellet deposition near the magnetic axis now possible only with relatively cold plasmas. For a given plasma the pellet speed is the only free parameter with regard to the penetration depth, since the pellet size determines the number of particles delivered to the plasma. In order to enable the central deposition also at higher plasma temperatures JET plans to employ an advanced gun system following the principles of hot pneumatics by adiabatic compression in two-stage guns capable of launching initially single, and in a later version multiple, pellets with velocities towards the 5 to 10 kms^{-1} range. We will describe here the present injector - concentrating on the launcher-machine interface and its upgrading - the development programme directed to make a single-pellet high-speed launcher possible and the planning of the implementation of this prototype launcher, as well as briefly outline the preparations for a future multi-pellet launcher system following from the prototype. (author). 9 refs, 4 figs.

20985 (IAEA-TECDOC–534, pp. 255-260) **A multishot pellet injector design.** Soerensen, H. (Euratom-Riso Association, Riso National Lab., Roskilde (Denmark)). International Atomic Energy Agency, Vienna (Austria). Dec 1989. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.* Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

A multibarrel pellet injector to inject a number of H_2 or D_2 pellets in succession is under development. It is planned for use at RFX in Padova and FTU in Frascati. The design is based on the use of pipe guns, where the pellet is formed by condensation from the gas phase inside the gun barrel, and thereafter blown out with a pulse of high pressure H_2 driver gas by means of a fast valve. Up to 8 pipe guns are built together in parallel; they are loaded simultaneously and thereafter fired successively. The pellets are transferred to the experiment through a guide tube system while the driver gas is removed by differential pumping. (author). 3 refs, 5 figs.

20986 (IAEA-TECDOC–534, pp. 261-267) **Development of a six-pellet injector for HELIOTRON E.** Kanno, M. (Kobe Steel Ltd (Japan). Mechanical Engineering Research Lab.); Fukuyama, H.; Baba, T.; Sudo, S. International Atomic Energy Agency, Vienna (Austria). Dec 1989. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.* Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

A pneumatic six-pellet injector has been developed for plasma fueling applications for HELIOTRON E. The cryogenic mechanism consists of two cryogenic housings cooled by liquid helium and a pellet production disk with six holes and the shaft assembly. Frozen hydrogen pellets are formed in the disk holes. The disk is rotated from the pellet production zone to the shooting position. The pellets are propelled by high pressure hydrogen or helium gas (at pressures of up to 100 bars) from 0.52 m gun barrels. Pellet velocity and firing intervals are variable for each shot. Pellet size can be changed by replacing the pellet production disk and the gun barrels. One example of a combination of six pellet holes is three groups of two pellets, each group having a diameter of 1.2 mm, 1.5 mm or 2.0 mm and all pellets having a thickness of 1 mm. Pellet velocity ranges from 400 m/s to 1400 m/s. The time interval between each pellet firing can be changed from 0 ms to more than 100 ms. More than 90% of the pellet shots are successful in operation. One cycle presently lasts 10 minutes. Recently, a six-pellet injector has been installed on HELIOTRON E. (author). 3 refs, 7 figs, 1 tab.

20987 (IAEA-TECDOC–534, pp. 269-273) **Electromagnetic railgun hydrogen pellet injector - Progress and prospect.** Kim, K. (Illinois Univ., Urbana, IL (USA). Fusion Technology Lab.). International Atomic Energy Agency, Vienna (Austria). Dec 1989. Grant DE-FG02-84ER52111. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.* Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

A two-stage, fuseless, plasma-arc-driven electromagnetic railgun system suitable for hydrogen pellet acceleration has been developed and successfully tested. The first stage is a combination of a hydrogen pellet generator and a gas gun, which is responsible for injecting a medium-velocity hydrogen pellet into the second-stage railgun through a coupling piece. As the pellet enters the railgun, a specially designed arc-initiation scheme electrically breaks down the propellant gas which has followed the pellet from the gas gun into the railgun, thus forming a conducting plasma-arc armature immediately behind the pellet. This arc formation event coincides with the triggering of the main railgun current and allows the plasma-arc armature to subsequently propel the hydrogen pellet to a high velocity. Using this two-stage acceleration scheme with a 1-m-long railgun barrel, solid hydrogen pellet velocities in excess of 2.2 km/s have been achieved for a pellet 3.2 mm in diameter and 4 mm in length. The objectives of this paper are two-fold: first, a critical review of the achievements thus far on the railgun hydrogen-pellet injector and second, a description of the most recent technological developments and their implications for future work, in particular, the prospect of employing a railgun pellet injector for future large devices. (author). 6 refs, 2 figs, 1 tab.

20988 (IAEA-TECDOC–534, pp. 275-279) **The ORNL/Tore Supra pellet injector and the E-beam rocket pellet accelerator.** Foster, C.A. (Oak Ridge National Lab., TN (USA)); Tsai, C.C.; Schechter, D.E. International Atomic Energy Agency, Vienna (Austria). Dec 1989. Contract DE-AC05-84OR21400. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.* Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

A pellet injector capable of firing up to 80 pellets of frozen deuterium at a speed of 1.2 km/s is being prepared for experiments on the Tore Supra superconducting tokamak as part of a U.S. Department of Energy and French CEA collaboration. The pellets are accelerated in a 1.5 m graphite composite rotor which turns at 8.000 rpm. Deuterium ice is made by freezing gas onto a liquid-helium cooled rotating disk. Pellets are punched from the rim of the disk and injected into the centrifuge. By varying the position of the punch with respect to the rim, pellets can be produced in a range of sizes from 1.5 mm to 3 mm. A computer system based on Multibus-1 hardware with software developed by CEA is used to control the operation of the injector. (author). 5 refs, 1 fig.

20989 (IAEA-TECDOC–534, pp. 283-288) **Injector development - Summary and review.** Kupschus, P. (Commission of the European Communities, Abingdon (UK). JET Joint Undertaking). International Atomic Energy Agency, Vienna (Austria). Dec 1989. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.* Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

The paper reviews the results presented at the meeting on injector development. (author). Refs.

20990 (IAEA-TECDOC–534, pp. 289-295) **Pellet ablation and ablation model development.** Houlberg, W.A. (Oak Ridge National Lab., TN (USA)). International Atomic Energy Agency, Vienna (Austria). Dec 1989. Contract DE-AC05-84OR21400. (CONF-8810231–: IAEA technical committee meeting on pellet injection and toroidal confinement, Gut Ising (Germany, F.R.), 24-26 Oct 1988). In *Pellet injection and toroidal confinement: Proceedings of a technical committee meeting held in Gut Ising, Federal Republic of Germany, 24-26 October 1988.* Order Number DE90616822. Available from NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

The results presented at the meeting on ablation phenomena is given and which includes pellet heating and ablation modelling, ablatant cloud expansion, pellet shielding, penetration depth and

velocity scaling, pellet wake structure. The survey is based mainly on the comparison of the existing theoretical models with various experimental observations. (author). 17 refs.

20991 (IPP–1/250) **Expected performance properties of the ASDEX upgrade toroidal field magnet derived from calculations and materials investigations.** Streibl, B.; Mukherjee, S. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1989. 35p. (In German). Order Number DE90753675. Available from NTIS (US Sales Only), PC A03/MF A01.

This is a summary of the TF-magnet calculation results for the 1984 phase-II proposal including supplements (also considering disturbances) of the performance of ASDEX Upgrade. Calculation results are as reliable as the assumptions incorporated, so that investigations of materials and design components were always used to complete the calculations. (orig.).

20992 (JAERI-M–89-154) **JAERI/U.S. collaborative program on fusion blanket neutronics: Analysis of phase IIA and IIB experiments.** Nakagawa, Masayuki (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Mori, Takamasa; Kosako, Kazuaki; Oyama, Yukio; Nakamura, Tomoo. Japan Atomic Energy Research Inst., Tokyo (Japan). Oct 1989. 193p. Order Number DE90749893. Available from NTIS (US Sales Only), PC A09/MF A01.

Phase IIa and IIb experiments of JAERI/U.S. Collaborative Program on Fusion Blanket Neutronics have been performed using the FNS facility at JAERI. The phase IIa experimental systems consist of the Li_2O test region, the rotating neutron target and the Li_2CO_3 container. In phase IIb, a beryllium layer is added to the inner wall to investigate a multiplier effect. Measured parameters are source characteristics by a foil activation method and spectrum measurements using both NE-213 and proton recoil counters. The measurements inside the Li_2O region included tritium production rates, reaction rate by foil activation and neutron spectrum measurements. Analysis for these parameters was performed by using two dimensional discrete ordinate codes DOT3.5 and DOT-DD, and a Monte Carlo code MORSE-DD. The nuclear data used were based on JENDL3/PR1 and PR2. ENDF/B-IV, V and the FNS file were used as activation cross sections. The configurations analysed for the test region were a reference, a beryllium front and a beryllium sandwiched systems in phase IIa, and a reference and a beryllium front with first wall systems in phase IIb. This document describes the results of analysis and comparison between the calculations and the measurements. The prediction accuracy of key parameters in a fusion reactor blanket are examined. The tritium production rates can be well predicted in the reference systems but are fairly underestimated in the system with a beryllium multiplier. Details of experiments and the experimental techniques are described separately in the another report. (author).

20993 (JAERI-M–89-214) **Measurement of double differential neutron emission cross sections at 14.1 MeV for Ca, Mn, Co and W.** Takahashi, Akito (Osaka Univ. (Japan)); Sasaki, Yasuhiro; Maekawa, Fujio; Sugimoto, Hisashi. Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment. c Dec 1989. 58p. (NEANDC(J)–144/U;INDC(JPN)–131/L). Available from Japan Atomic Energy Research Inst., Tokai-mura, Naka-gun, Ibaraki-ken 319-11, Japan.

Using the neutron TOF spectrometer at OKTAVIAN, double differential neutron emission cross sections at 14.1 MeV were measured for Ca, Mn, Co and W which are of interest for shielding and structural material elements of fusion reactors. Data were obtained for 16 angle points from 15 to 160 deg in the LAB system for each element, covering the secondary neutron energy region from 0.5 MeV to 15 MeV. Statistics and energy resolution of obtained data are satisfactory. The double differential cross sections in the LAB system were once converted to those in the center-of-mass system and integrated over scattering angle to obtain neutron emission spectra. Angle-differential cross sections were obtained for the elastic and discrete-inelastic scatterings whose peaks in DDX spectra could be resolved. The measured DDX data are so numerous that only their graphs are shown in this report. However, the graphs and numerical tables are given for the neutron emission spectra nd the angle-differential cross sections. In the graphs, preliminary comparisons are made with evaluated data. The ENDF/B-IV data for Ca are satisfactory in the high energy region, but overestimate the experimental values in the low energy region. The JENDL-3T data for Mn reproduce well the angle-integrated neutron emission spectrum, though underestimation is seen in the 6–13 MeV region. It is noted that ENDF/B-IV underestimates the emission spectrum of Co in the 3–13 MeV region. The ENDF/B-IV data for W do not agree at all with the experimental spectral patterns. 8 refs., 82 figs., 9 tabs.

20994 (LA-UR–90-452) **Defect structures in copper and gold irradiated with fast neutrons, 14 MeV neutrons and 600–800 MeV protons.** Horsewell, A. (Risoe National Lab., Roskilde (Denmark). Metallurgy Dept.); Singh, B.N.; Proennecke, S.; Sommer, W.F.; Heinisch, H.L. Los Alamos National Lab., NM (USA). [1989]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-891204–20: 4. international conference on fusion reactor materials, Kyoto (Japan), 4-8 Dec 1989). Order Number DE90007529. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Copper and Gold have been irradiated with fast neutrons (mixed spectrum thermal reactor), 14 MeV neutrons (RTNS-II) and 600–800 MeV protons (PIREX II & LAMPF) at 300–373 K over a dose range of 10^{21}–10^{24} particles·m^{-2}. Defect cluster concentrations and sizes have been obtained by transmission electron microscopy. The variation in cascade damage structures resulting from a change in average recoil energy from 10^4 to 10^6 eV is shown. 4 refs., 1 fig., 3 tabs.

20995 (LA-UR–90-599) **Energy deposition measurements for e-beam pumped excimer lasers.** Cates, M.C. (Maxwell Labs., Inc., San Diego, CA (USA)); Robertson, K.L.; Melcher, P.C.; Greene, D.P.; Romero, V.O. Los Alamos National Lab., NM (USA). [1989]. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-891261–8: International conference on lasers '89, New Orleans, LA (USA), 3-8 Dec 1989). Order Number DE90007545. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The energy deposition of the e-beam pumped MLI Two-Meter Laser was measured and compared using dosimetry films, electron calorimetry, current measurements, and pressure rise measurements. The measurements agreed within their uncertainties. 7 refs., 10 figs.

20996 (ORNL/ATD–28/V1) **An interim report on the materials and selection criteria analysis for the Compact Ignition Tokamak Toroidal Field Coil Turn-to-Turn Insulation System: Volume 1.** Campbell, V.W.; Dooley, J.B.; Hubrig, J.G.; Janke, C.J.; McManamy, T.J.; Welch, D.E. Oak Ridge National Lab., TN (USA). Jan 1990. 78p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90005818. Available from NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

Design criteria for the Compact Ignition Tokamak, Toroidal-Field (TF) Coil, Turn-to-Turn Insulation System require an insulation sheet and bonding system that will survive cryogenic cycling in a radiation environment and maintain structural integrity during exposure to the significant compressive and shear loads associated with each operating cycle. For thermosetting resin systems, a complex interactive dependency exists between optimum peak value, in-service property performance capabilities of candidate generic materials; key handling and processing parameters required to achieve their optimum in-service property performance as an insulation system; and suitability of their handling and processing parameters as a function of design configuration and assembly methodology. This dependency is assessed in a weighted study matrix in which two principal programmatic approaches for the development of the TF Coil Subassembly Insulation System have been identified. From this matrix study, two viable approaches to the fabrication of the insulation sheet were identified: use of a press-formed sheet bonded in place with epoxy for mechanical bonding and tolerance take-up and formation of the insulation sheet by placement of dry cloth and subsequent vacuum pressure impregnation. Laboratory testing was conducted to screen a number of combinations of resins and hardeners on a generic basis. These combinations were chosen for their performance in similar applications. Specimens were tested to screen viscosity, thermal-shock tolerance, and cryogenic tolerance. Cryogenic shock and

cryogenic temperature proved to be extremely lethal to many combinations of resin, hardener, and cure. Two combinations survived: a heavily flexibilized bisphenol A resin with a flexibilized amine hardener and a bisphenol A resin with cycloaliphatic amine hardener. 7 refs., 12 figs., 6 tabs.

20997 (ORNL/FTR–3538) **[Management session for the International Thermonuclear Experimental Reactor]: Foreign trip report, February 4, 1990–February 11, 1990.** Reuther, T.C. Oak Ridge National Lab., TN (USA). 26 Feb 1990. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90007486. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The purpose of this travel was twofold: (1) to meet with the managing directors of the ITER conceptual design activity to advance their evaluation and decision on a proposal to establish coordination among the existing fusion materials research and development programs of the ITER parties in support of the ITER design; and (2) to participate in a specialists meeting to evaluate current data and formulate a materials properties data base for use in the conceptual design phase of the ITER activity.

20998 (PPPL–2677) **Numerical simulations of in-situ neutron detector calibration experiments on the Tokamak Fusion Test Reactor.** Ku, L.P.; Hendel, H.W.; Liew, S.L.; Strachan, J.D. Princeton Univ., NJ (USA). Plasma Physics Lab. Feb 1990. 34p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03073. Order Number DE90006348. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Accurate determinations of fusion neutron yields on the TFTR require that the neutron detectors be absolutely calibrated in-situ, using neutron sources of known strengths. For such calibrations, numerical simulations of neutron transport can be powerful tools in the design of experiments and the study of measurement results. On the TFTR, 'numerical calibration experiments' have been frequently used to complement actual detector calibrations. We present calculational approaches and transport models used in these numerical simulations, and summarize the results from simulating the calibration of ^{235}U fission detectors carried out in December 1988. 12 refs., 9 figs., 6 tabs.

20999 (SAND–89-7107) **Magnetohydrodynamic modeling of plasma opening switches and gas puff plasmas.** Roderick, N.F. (New Mexico Univ., Albuquerque, NM (USA). Dept. of Chemical and Nuclear Engineering); Payne, S.S.; Nicholson, J. Sandia National Labs., Albuquerque, NM (USA); New Mexico Univ., Albuquerque, NM (USA). Dept. of Chemical and Nuclear Engineering. Nov 1989. 72p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Contract No. 38-1233. Order Number DE90005825. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This work performed over this twenty-eight month contract period falls into two categories: studies of fluid plasma and transport properties (specifically, microturbulent resistivity) in opening switch plasmas in support of the SNLA PBFA-II pulsed power program; and calculations of two-dimensional effects in gas puff plasmas in support of the SNLA NARYA program. Results of this work are reported here. 34 refs., 30 figs.

21000 (SAND–89-7154) **Dynamics of plasma injection along magnetic field lines in the PBFA II [Particle Beam Fusion Accelerator II] plasma opening switch.** Frese, M.H. (NumerEx, Albuquerque, NM (USA)). Sandia National Labs., Albuquerque, NM (USA); NumerEx, Albuquerque, NM (USA). Nov 1989. 37p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789. Order Number DE90006751. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In the magnetically injected plasma (MIP) plasma opening switch (POS) presently under study for use on the Particle Beam Fusion Accelerator II (PBFA II), plasma is injected along an imposed poloidal field to control the position of the plasma. The magnetic field and the plasma density combine to make the Alfven velocity very high relative to the injection velocity of the plasma. In fact, the ration of these velocities, the Alfven-Mach number of the flow, ranges from 0.001 to 0.01. Explicit computation at these low Mach numbers is exceedingly tedious, and implicit computation without a very high convergence rate scheme is little better. However, the physical effect is clear: the field lines are effectively very stiff and not subject to displacement by the plasma. The plasma motion may thus be computed by simply restricting the velocity to lie along the field. Simulations in the true experimental geometry using this approach agree qualitatively with microwave interferometry measurements of the plasma density in the experimental test stand. The agreement is quantitative, subject only to the adjustment of the unknown plasma source mass flux rate. 2 refs., 17 figs.

21001 (UCID–21836) **Superconducting magnet development capability of the LLNL [Lawrence Livermore National Laboratory] High Field Test Facility.** Miller, J.R.; Shen, S.; Summers, L.T. Lawrence Livermore National Lab., CA (USA). Feb 1990. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. Order Number DE90006355. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper discusses the following topics: High-Field Test Facility Equipment at LLNL; FENIX Magnet Facility; High-Field Test Facility (HFTF) 2-m Solenoid; Cryogenic Mechanical Test Facility; Electro-Mechanical Conductor Test Apparatus; Electro-Mechanical Wire Test Apparatus; FENIX/HFTF Data System and Network Topology; Helium Gas Management System (HGMS); Airco Helium Liquefier/Refrigerator; CTI 2800 Helium Liquefier; and MFTF-B/ITER Magnet Test Facility.

21002 (UCLA/PPG–1253) **A new plasma-surface interactions research facility: PISCES-B and first materials erosion experiments on boronized graphite.** Hirooka, Y.; Conn, R.W.; Sketchley, T.; Leung, W.K.; Doerner, R.; Elverum, J.; Gunner, G.; Khandagle, M.; Lehmer, R.; Luong, P. California Univ., Los Angeles, CA (USA). Inst. of Plasma and Fusion Research. Aug 1989. 25p. Sponsored by U.S. DOE Energy Research. DOE Contract FG03-86ER52130. Order Number DE90006336. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A new plasma-surface interactions research facility: PISCES-B has been designed and constructed at University of California, Los Angeles. The entire vacuum chamber is bakable and a base pressure of the order of 10^{-8} Torr is attainable using two turbo molecular pumps with a total pumping speed of 6000 *l*/s. The PISCES-B facility can generate continuous plasmas of argon, helium, hydrogen, deuterium and nitrogen. The density of these plasmas ranges from 1×10^{-11} to 3×10^{-13} cm^{-3} and the electron temperature ranges from 3 to 51 eV. The plasma bombardment flux to a target surface inserted in the plasma column can be varied from 1×10^{17} to 8×10^{18} ions cm^{-2} s^{-1}. Due to the high pumping speed, the neutral pressure of the working gas during plasma generation is controllable in the wide range from 3×10^{-5} to 1×10^{-3} Torr. These conditions are similar to those seen at the limiter and divertor areas in toroidal fusion devices. Using the PISCES-B facility, first materials erosion experiments have been conducted on 3% boronized graphites and iso-graphites as the reference materials. The chemical sputtering yield due to hydrogen plasma bombardment at 300 eV for 3% boronized graphite has been found to be about 30% smaller than that for iso-graphites at temperatures from room temperature to 900°C. Also, radiation enhanced sublimation due to hydrogen plasma bombardment at 400 eV is found to be suppressed by 20-30% for 3% boronized graphite at temperatures up to 1300°C. No significant surface composition change is observed after hydrogen plasma bombardment to a fluence of the order of 10^{22} ions cm^{-2}. 30 refs., 9 figs., 2 tabs.

21003 (UCLA/PPG–1256) **Spectroscopic studies of carbon impurities in PISCES-A.** Ra, Y. (California Univ., Los Angeles, CA (USA). Inst. of Plasma and Fusion Research); Hirooka, Y.; Leung, W.K.; Conn, R.W.; Pospieszczyk, A. California Univ., Los Angeles, CA (USA). Inst. of Plasma and Fusion Research. Aug 1989. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract FG03-86ER52130. (CONF-891093–25: 36. American Vacuum Society national vacuum symposium, Boston, MA (USA), 23-27 Oct 1989). Order Number DE90006334. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The graphite used for the limiter of the tokamak reactor produces carbon-containing molecular impurities as a result of the interactions with the edge plasma. The behavior of these molecular impurities has been studied using emission spectroscopy. The

present study includes: finding molecular bands and atomic lines in the visible spectral range which can be used for the study of the molecular impurities, studying the breakup processes of the molecular impurities on their way from the source into the plasma, developing a spectroscopic diagnostic method for the absolute measurement of the molecular impurity flux resulting from graphite erosion. For these studies, carbon-containing molecules such as CH_4, C_2H_2, C_2H_4, and CO_2 were injected into the tokamak-boundary,like plasma generated by PISCES-A. The spectrograms of these gases were taken. Many useful bands and lines were determined from the spectrograms. The breakup processes of these gases were studied by observing the spatial profiles of the emission of the molecules and their radicals for different plasma conditions. For the absolute measurement of the eroded molecular impurity flux, the photon efficiency of the lines and bands were found by measuring the absolute number of the emitted photons and injected gas molecules. The chemical sputtering yield of graphite by hydrogen plasma was spectroscopically measured using the previously obtained photon efficiencies. It showed good agreement with results obtained by weight loss measurements. 16 refs., 7 figs., 1 tab.

21004 (UCRL–21231) **Progress in the CW operation of a 140 GHz gyrotron.** Felch, K. (Varian Associates, Inc., Palo Alto, CA (USA)); Jongewaard, E.; Jory, H.; Hess, C.; Huey, H.; Neilson, J.; Pendleton, R.; Pirkle, D. Lawrence Livermore National Lab., CA (USA); Varian Associates, Inc., Palo Alto, CA (USA). Sep 1989. 3p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. (CONF-8910353–2: 14. international conference on infrared and millimeter waves, Wuerzburg (Germany, F.R.), 2 Oct 1989). Order Number DE90007382. Available from NTIS, PC A02/MF A01; OSTI; INIS.

Tests on a 140 GHz, whispering-gallery-mode gyrotron have resulted in short-pulse power levels of 820 kW and average power levels of 81 kW. Tests are currently underway on a new tube with the goal of achieving an ouput power of 400 kW CW. 1 ref.

21005 (UCRL–101154) **The ETA-2 induction linac as a high average power FEL driver.** Nexsen, W.E.; Atkinson, D.P.; Barrett, D.M.; Chen, Y.J.; Clark, J.C.; Griffith, L.V.; Kirbie, H.C.; Newton, M.A.; Paul, A.C.; Sampayan, S. Lawrence Livermore National Lab., CA (USA). 16 Oct 1989. 17p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-48. (CONF-8908134–29: 11. international free electron laser conference, Naples, FL (USA), 28 Aug - 1 sep 1989). Order Number DE90006987. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Experimental Test Accelerator-II (ETA-II) is the first induction linac designed specifically to FEL requirements. It primarily is intended to demonstrate induction accelerator technology for high average power, high brightness electron beams, and will be used to drive a 140 and 250 GHz microwave FEL for plasma heating experiments in the Microwave Tokamak Experiment (MTX) at LLNL. Its features include high vacuum design which allows the use of an intrinsically bright dispenser cathode, induction cells designed to minimize BBU growth rate, and careful attention to magnetic alignment to minimize radial sweep due to beam corkscrew. The use of magnetic switches allows high average power operation. At present ETA-II is being used to drive 140 GHz plasma heating experiments. These experiments require nominal beam parameters of 6 Mev energy, 2kA current, 20ns pulse width and a brightness of 1 $\times$ 10^8 A/(m-rad)^2 at the wiggler with a pulse repetition frequency (PRF) of 0.5 Hz. Future 250 GHz experiments require beam parameters of 10 Mev energy, 3kA current, 50ns pulse width and a brightness of 1 $\times$ 10^8 A/(m-rad)^2 with a 5 kHz PRF for 0.5 sec. In this paper we discuss the present status of ETA-II parameters and the phased development program necessary to satisfy these future requirements. 13 refs., 9 figs., 1 tab.

21006 (UCRL–101516) **Direct implicit simulation of collisionless magnetic reconnection.** Francis, G.E.; Hewett, D.W.; Max, C.E. Lawrence Livermore National Lab., CA (USA). 12 Jul 1989. 22p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-8903131–4: Chapman conference on the physics of magnetic flux ropes, Hamilton (Bermuda), 27-31 Mar 1989). Order Number DE90007250. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Collisionless reconnection of magnetic field lines depends upon electron inertia effects and details of the electron and ion distribution functions, thus requiring a kinetic description of both. Though traditional explicit PIC techniques provide this description in principle, they are severely limited in parameters by time step constraints. This parameter regime has been expanded in this work by using the recently constructed 2.5 D electromagnetic code AVANTI. The code runs stably with arbitrarily large Δt and is quite robust with respect to large fluctuations occurring due to small numbers of particles per cell. We find excellent agreement with linear electron tearing theory for early simulation times, provided electrostatic effects are included in the theory. In the non-linear regime following tearing, we observe electrostatic ringing of electrons and trapped flux into the magnetic island, superposed on linear growth determined by the ion sound velocity. It is found that the inclusion of a guide magnetic field (magnetic shear) severely slows the initial stages of reconnection and damps out the electrostatic ringing if local values of the guide field are above a threshold determined by questions of electron mobility. 21 refs., 8 figs.

21007 (UCRL–101782) **ITER [International Thermonuclear Experimental Reactor] magnet development program at LLNL [Lawrence Livermore National Laboratory].** Shen, S.S. Lawrence Livermore National Lab., CA (USA). Sep 1989. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. (CONF-8909184–2: IAEA specialists meeting on superconducting materials and magnets, Tokyo (Japan), 4-6 Sep 1989). Order Number DE90006992. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The International Thermonuclear Experimental Reactor (ITER) magnet development program at Lawrence Livermore National Laboratory mainly involves developing high-performance, radiation-tolerant magnet concepts. Model coils, full-scale conductors, and insulation systems will be fabricated and tested. This paper briefly describes the program plan. Also included is the description of the Fusion Engineering International Experimental Magnet Facility (FENIX) which is currently under construction for testing full-scale ITER conductors to 40 kA and 14 T. Its design parameters and schedule are reviewed. 2 refs., 2 figs., 1 tab.

21008 (UCRL–101784) **Design considerations in achieving 1 MW CW operation with a whispering-gallery-mode gyrotron.** Felch, K. (Varian Associates, Inc., Palo Alto, CA (USA)); Feinstein, J.; Hess, C.; Huey, H.; Jongewaard, E.; Jory, H.; Neilson, J.; Pendleton, R.; Pirkle, D.; Zitelli, L. Lawrence Livermore National Lab., CA (USA); Varian Associates, Inc., Palo Alto, CA (USA). Sep 1989. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. (CONF-891205–3: IEEE international electron devices meeting, Washington, DC (USA), 3-6 Dec 1989). Order Number DE90007283. Available from NTIS, PC A02/MF A01; OSTI; INIS.

Varian is developing high-power, CW gyrotrons at frequencies in the range 100 GHz to 150 GHz, for use in electron cyclotron heating applications. Early test vehicles have utilized a $TE_{15,2,1}$ interaction cavity, have achieved short-pulse power levels of 820 kW and average power levels of 80 kW at 140 GHz. Present tests are aimed at reaching 400 kW under CW operating conditions and up to 1 MW for short pulse durations. Work is also underway on modifications to the present design that will enable power levels of up to 1 MW CW to be achieved. 7 refs., 2 figs.

21009 (UCRL–101793) **Design of an induction linac driven CARM [Cyclotron Auto Resonance Maser] oscillator at 250 GHz.** Caplan, M.; Kulke, B. Lawrence Livermore National Lab., CA (USA). 24 Jan 1990. 3p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. (CONF-8910353–1: 14. international conference on infrared and millimeter waves, Wuerzburg (Germany, F.R.), 2 Oct 1989). Order Number DE90007404. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

We present the design of a 250 GHz, 400 MW Cyclotron Auto Resonance Maser (CARM) oscillator driven by a 1 KA, 2 MeV electron beam produced by the induction linac at the ARC facility of LLNL. The oscillator circuit is designed as a feedback amplifier operating in the TE_{11} mode at ten times cutoff terminated at each end with Bragg reflectors. Theory and cold test results are in good

agreement for a manufactured Bragg reflector using 50 μm corrugations to ensure mode purity. The CARM is to be operational by February 1990. 3 figs., 2 tabs.

21010 (UCRL–102755) **Neutrons and gamma transport through materials of interest to fusion reactors.** Hansen, L.F. Lawrence Livermore National Lab., CA (USA). 16 Jun 1990. 15p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-8909300–1: International school on nuclear physics, neutron physics and nuclear energy conference, Varna (Bulgaria), 29 Sep - 7 oct 1989). Order Number DE90007254. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The need for accurate integral measurements to validate the cross sections libraries and codes used in the conceptual design of fusion reactors is shown. Measurements of the neutron and gamma-ray leakage spectra from spherical assemblies pulsed with 14-MeV neutrons are discussed, together with Monte Carlo calculations using the code TART with the ENDF/B-V and ENDL neutron-photon libraries. 10 refs., 4 figs., 2 tabs.

21011 Proceedings of the nuclear power and fusion programs of the Canadian Nuclear Society. 248p. The Canadian Nuclear Association, Toronto, Ontario Canada (1987). (CONF-8705187–: 37. Canadian chemical engineering conference (Canadian engineering centennial convention), Montreal (Canada), 18-22 May 1987).

These proceedings contain 30 papers grouped under the headings of: Power reactors, Safety and regulation, unique achievements, Fuel cycle, the future, Fusion-Canadian and worldwide Fusion engineering and Fusion-An alternative energy source.

21012 Numerical simulations of relativistic double layers. Sulkanen, M.E. (Space Plasma Physics Group, Los Alamos National Lab. (US)); Borovsky, J.E. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The authors present the results of particle-in-cell numerical simulations of one-dimensional, time-dependent, fully relativistic double layers. They extend the scaling law for the layer width to relativistic potential drops and plasma temperatures. They discuss quantitatively the layer creation and disruption cycles, as well as the beam-plasma instabilities driven by the layer. Relativistic double layers may be a mechanism to produce intense radiation as observed in active galactic nuclei and pulsars, primarily by collective bremsstrahlung involving the charge-bunched electron beam and background plasma electrons. They discuss the radiation spectrum and total power emitted by this process based on the degree of beam-plasma bunching observed by the numerical simulations.

21013 Magnetic field error measurements and effects on plasma in the MST reversed field pinch. Almagri, A.F. (Wisconsin Univ., Madison, WI (USA)); Assadi, S.; Dexter, R.N.; Prager, S.C.; Sarff, J.S.; Sprott, J.C. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

MST (Madison Symmetric Torus) has been in operation since June 1988. The vacuum vessel is 5-cm-thick aluminum, 1.5 meters in major radius and 0.52 meters in minor radius. The vessel serves as the toroidal field winding and conducting shell, with a single poloidal gap and a single toroidal gap. These gaps are a potential source of error fields if great care is not used in designing the winding system. The toroidal field system produces a vacuum error field with a dominant n=4, m=0 fourier component of magnitude of order 0.2% of the toroidal field on axis as was expected. With the present temporary ohmic winding the maximum radial magnetic field at the poloidal gap for a typical plasma is about 60% of the poloidal field at the wall. The radial and poloidal fields at the poloidal gap are measured. Correction coils are added to the poloidal gap to cancel the error field. With the correction coils the radial field is reduced to about 25%. Detailed structure of these fields as well as the radial fields at the toroidal gap are presented.

21014 Disproof of Cowling's theorem. Alexeff, I. (Univ. of Tennessee (US)). pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

In the study of planetary and sellar magnetic fields, a thermally driven MHD generator is generally assumed to be the source of the field. Cowling's theorem is used to prove that cylindrically symmetric models are not capable of producing steady-state magnetic fields. The theorem is based on the fact that there is a current loop that lies inside the conducting medium. This loop has no magnetic field at right angles to the current and so a current feed by $E = \nu XB$ cannot exist. Thus, according to the author, the current loop must decay and the model must be invalid. The object of this discussion is to demonstrate that other mechanisms for feeding a current loop can occur than the νXB process. For example, collisional processes can cause current to migrate into electric-field-free regions.

21015 Flow, heat transfer, and wavefront distortion in a gas cooled disk amplifier. Albrecht, G.F. (Univ. of California, Lawrence Livermore National Lab., Livermore, CA (US)); Sutton, S.B.; Robey, H.F.; Freitas, B.L. pp. 203 of High power and solid state lasers II. Dubie, G SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (1989). DOE Contract W-7405-ENG-48. (CONF-890157–: 2. conference on high power and solid state lasers, Los Angeles, CA (USA), 19-20 Jan 1989).

The potential of the gas cooled disk architecture to operate at kilowatt to megawatt levels of average power is explored. The key issues investigated are flow and heat transfer in the cooling channel, the power required to perform the cooling and its implications for overall system efficiency, flow conditioning in the drift region, losses due to turbulent scattering, and beam quality due to optical distortions. In all cases an understanding of the issues leads to ways to mitigate or eliminate deleterious effects. The authors conclude that the gas cooled disk geometry is an architecture which can lead to devices which are capable of average power levels reaching from a few kilowatts up to hundreds of kilowatts per beam line without stressing existing engineering or technology.

21016 Parametric studies of high-heat-flux-induced erosion of surfaces in an electrothermal accelerator. Hankins, O. (North Carolina State Univ., Raleigh, NC (USA)); Bourham, M.; Auciello, O.; Stock, J.; Gilligan, J.; Wehring, B. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Ablation and melting of surfaces in devices such as electromagnetic launchers and electrothermal accelerators is of fundamental concern. The plasmas in these devices can exposes surfaces to intense heat fluxes. In order to increase lifetime and maximize device efficiency, erosion of critical components (e.g., rails, insulators, barrels) must be kept to a minimum. Numerous materials have been tested as to whether they survive realistic conditions. However, the fundamental mechanisms of energy transport through the plasma region immediately adjacent to the surface have largely been unexplored. This plasma boundary layer region is referred to as the vapor shield because they vapor absorbs the incoming energy (as internal energy) and prevents it from reaching the surface. This region is characterized by large temperature and density gradients and is dominated by the source of ablated surface material and the absorption of incident energy. It is predicted that the addition of a strong magnetic field parallel to the surface will affect the energy transport in the vapor shield by reducing crossfield thermal conduction and possibly increasing the radiation energy density. The authors report on experimental efforts to verify the existence of the vapor shield and to measure the effectiveness of the shield in reducing the surface erosion.

21017 Spectroscopic investigation of the RGS-II hypervelocity plasma armature. Barrett, B.D. (Univ. of Texas at Arlington, Center for Energy Conversion Research, Arlington, TX (US)); Baker, M.C.; Nunnally, W.C.; Bengtson, R.D. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science

(Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The authors report a spectroscopic investigation of the plasma armature in the railgun simulator, RGS-II. RGS-II is capable of accelerating the plasma armature to velocities up to 20 km/sc and producing armature currents up to 300 kA. The optical signal is extracted at the mid-bore position by means of a fiber optic bundle. Emission spectra are recorded by an optical multichannel analyzer, OMA, system. The emission spectra obtained are used to identify the plasma constituents. Relative intensities between neutral and ionic species are correlated with interferometric measurements of the electron density to estimate the plasma temperature via the Saha equations. Effects of the ambient chamber pressure and total armature current on the plasma armature are being studied over a range of 200 mT to atmospheric pressure and from 50 to 300 kA, respectively. This paper presents data and discusses the findings.

21018 Magnetohydrodynamic simulations of Gamble I POS with Hall effect. Roderick, N.F. (New Mexico Univ., Albuquerque, NM (USA)); Frese, M.H.; Peterkin, R.E.; Payne, S.S. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Two dimensional single fluid magnetohydrodynamic simulations have been conducted to investigate the effects of the Hall electric field on magnetic field transport in plasma opening switches of the type used on Gamble I. The Hall terms were included in the magnetic field transport equation in the two dimensional simulation code MACH2 through the use of a generalized Ohm's law. Calculations show the Hall terms augment the field transport previously observed to occur through ion fluid motion and diffusion. For modest values of microturbulent collision frequency, board current channels were observed . Results also show the magnetic field transport to be affected by the cathode boundary conditions with the Hall terms included. In all cases center of mass motion was slight.

21019 Dynamics of cusp produced rotating beam. Choe, J. (Naval Surface Warfare Center, Silver Spring, MD (USA)); Boulais, K.; Choi, E.; Ayres, V. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The advent of the cusptron and the peniotron tubes have renewed interest in the axis-rotating electron beam. One of the most successful methods of producing the axis-encircling beam is by magnetic cusp injection . This paper examines the fundamental properties of the cusp dynamics by using simplified, but still realistic, models that assess the effects of the various experimental parameters in terms of gain reduction, and attempts to devise experimentally realizable optimum beam configurations. Special emphases are given to off-centering sources, and methods to reduce them. The single particle orbit equation is solved using simple approximations from which the effects of several field contributing factors are examined. The experimental factors considered are the magnetic field profiles including the degree of the field reversal, the cusp transition thickness, and the adiabatic compression after the transition.

21020 Armature formation and performance in a railgun using a two-stage light-gas gun injector. Hawke, R.S. (Lawrence Livermore National Lab., CA (USA)); Susoeff, A.R.; Asay, J.R.; Hall, C.A.; Konrad, C.H.; Hickman, R.J.; Sauve, J.L. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). DOE Contract W-7405-ENG-48. (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The use of a two-stage light-gas gun (2SLGG) as a pre-accelerator in combination with a railgun is expected to significantly reduce barrel ablation and improve overall performance. In particular, the use of a hydrogen 2SLGG provides injection velocities of 6 to 8 km/s and a pure hydrogen environment immediately behind the projectile as it enters a railgun. To continue acceleration of the projectile, a plasma armature must be formed. The authors explored two methods of converting a portion of the fast-moving hydrogen gas into a plasma armature. This paper reports on tests in which armatures were formed and used to further accelerate a projectile. This work is part of STARFIRE, the project to develop a hypervelocity railgun.

21021 Microwiggler free electron laser experiment. Chen, S.C. (Dept. of Physics and Plasma Fusion Center, MIT, Cambridge, MA (US)); Bekefi, G.; Temkin, R.; Stoner, R. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

In free electron laser (FEL) operation, wigglers with small periodicities reduce the electron beam energy required for producing high frequency radiation. Microwigglers with periodicities less than 1 cm combined with the high quality beams generated by photoelectric injectors may result in compact and efficient short-wavelength FELs. The authors present the design, construction, and test results of novel micor-wiggler structures with periodicities of 2.4 to 8 mm, in which the magnetic field in each half-period is independently adjustable. The experimentally demonstrated tunability of field amplitudes provides versatile means for enhancing the FEL performance. A microwiggler FEL experiment driven by a 300 kV Marx and a thermionic electron gun is described.

21022 High power microwave emission from cyclotron autoresonance maser (CARM) interactions in microsecond, intense electron beams. Gilgenbach, R.M. (Intense Energy Beam Interaction Lab., Nuclear Engineering Dept., Univ. of Michigan, Ann Arbor, MI (US)); Wang, J.G.; Choi, J.J.; Outten, C.A.; Spencer, T. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The authors report experiments performed in which multi-megawatt, frequency tunable, microwave radiation has been generated in the K-band and X-band by means of cyclotron maser mechanism on intense electron beams with microsecond pulselengths. The masers operate as oscillators with cylindrical cavities in the TE_{11n} modes or TE_{01n} modes. Experiments have been performed utilizing two long pulse, intense electron beam accelerators. Initial experiments used a generator with parameters: voltage = 0.4 MV, current = 1 kA, and pulselength = 0.3-0.4 μs. These experiments have generated over 3 MW of K-band microwaver radiation, magnetically tunable from 14 GHz through 15.5 GH_z. The frequency of this radiation corresponds to the cyclotron autoresonant maser (CARM) forward wave interaction. In the same experiments, the authors observed MW level X-band radiation, magnetically tunable from 10-12 GH_z. The frequency of this emission indicates that it originates from the cyclotron maser backward wave interaction or absolute instability. Microwave pulselength of 0.1 μs to 0.2μs were generated in these initial experiments.

21023 Status of the design and construction of the Confinement Physics Research Facility (CPRF) and the ZTH experiment. Thullen, P. (Los Alamos National Lab., NM (USA)); Schoenberg, K.F.; DiMarco, J.N. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Design and construction of the Confinement Physics Research Facilty (CPRF) and the Reversed Field Pinch fusion experiment ZTH are continuing. Integrated system checkout is scheduled to begin in the first quarter of 1993. First operation will be at up to 1.7 MA plasma current with 2 MA upon the addition of power supplies and 4 MA by the addition of power supplies and upgrading of key components. Site preparation is continuing, installation of the 1430 MVA generator has begun, some magnet coils have been received, construction of the torus is underway and all components are at or

near the final design stage. A summary of the physics operating point of ZTH and the status of the construction are presented.

21024 Propagation of the front of an electron beam injected into a magnetized plasma. Chan, L.Y. (California Univ., Los Angeles, CA (USA). Dept. of Physics); Stenzel, R.L. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The front of an electron beam, injected into a magnetized plasma, is measured with spatial and temporal resolution using fast optical and rf probes to investigate how its propagation depends on the basic beam and plasma parameters, as well as self-consistent space-charge fields, return currents and instabilities. The authors report what they observed optically from time-of-flight measurements of the light front. The speed at which the front propagates into the background magnetoplasma is inversely related to the beam current density and much less than the pulsed cathode voltage, i.e. $1/2\ mv^2_b$ = 20%-50% eV_b. This suggests that space-charge fields due to the injected beam itself is retarding the propagation of the beam front into the plasma. This work is relevant for active beam experiments in space, as well as time-dependent, space-charge related plasma physics.

21025 Electron beam generation in high voltage glow discharges. Rocca, J.J. (Colorado State Univ., Fort Collins, CO (USA). Dept. of Electrical Engineering); Szapiro, B.; Murray, C. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The generation of intense CW and pulsed electron beams in glow discharges in reviewed. Glow discharge electron guns operate at a pressure of the order of 1 Torr and often have an advantage in applications that require a broad area electron beam in a gaseous atmosphere, such as laser excitation and some aspects of materials processing. Aspects of electron gun design are covered. Diagnostics of the high voltage glow discharges including the electric field distribution mapped by Doppler free laser spectroscopy, and plasma density and electron temperature measurements of the electron yield of different cathode materials under glow discharge conditions are presented.

21026 The temporal development of hollow cathode discharges. Ngo, M.T. (Old Dominion Univ., Norfolk, VA (USA)); Gerdin, G.; Schoenbach, K.; Lee, J. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The authors report a linear discharge system with a plane anode and a hollow cathode used to study discharges in He at pressures between 100 mTorr and several Torr. A 10 μs voltage pulse of variable amplitude was applied to the electrodes and the discharge voltage and current was measured. Two distinct discharge modes were observed, a high current ($I \geq 100A$) mode, and a low current ($I \simeq 500mA$) mode, which is characterized by a filamentary plasma of about 1 mm diameter on the axis of the electrodes. At the mode transition, P_t, the discharge current changes over four orders of magnitude in the pressure range of few mTorr. They discuss how the two modes represent different stages in the development of the hollow cathode discharge.

21027 Laser wakefield acceleration. Esarey, E. (Naval Research Lab., Washington, DC (USA). Plasma Physics Div.); Ting, A.; Sprangle, P. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The laser wakefield accelerator (LWFA) is a novel plasma based electron acceleration scheme which utilizes a relativistic optical guiding mechanism for laser pulse propagation. In the LWFA, a short, high power, single frequency laser pulse is propagated through a plasma. As the laser pulse propagates, its radial and axial ponderomotive forces nonresonantly generate large amplitude plasma waves (wakefields) with a phase velocity equal to the group velocity of the pulse. A properly phased electron bunch may then be accelerated by the axial wakefield and focused by the transverse wakefield. Optical guiding of the laser pulse in the plasma is necessary in order to achieve high energies in a single stage of acceleration. At sufficiently high laser powers, optical guiding may be achieved through relativistic effects associated with the plasma electrons. Preliminary analysis indicates that this scheme may overcome some of the difficulties present in the plasma beat wave accelerator and in the plasma wakefield accelerator. Analytical and numerical calculations are presented which study both laser pulse propagation within a plasma as well as the subsequent generation of large amplitude plasma waves. In addition, the generation of large amplitude plasma waves in regimes where the plasma waves become highly nonlinear is examined.

21028 Effects of wall ablation on the internal structure and dynamics of a railgun plasma arc. Frese, M.H. (Numerex, Albuquerque, NM (US)). pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Two kinds simulations of a railgun plasma arc have been performed using MACH2, a two-dimensional diffusive magnetohydrodynamics code. The simulations are intended to model the arc in the plane of symmetry which intersects the rails, and thus effectively model the arc in a gun with infinitely wide rails. Both kinds of simulations include the effects of magnetic field convection by plasma motion, magnetic field diffusion, energy transport by thermal diffusion and equilibrium radiation diffusion, and the affect of the acceleration of the arc and projectile. The first set of simulations was run without any wall effects. In the second set of simulations, the boundary conditions permit energy flux to the rails and to the projectile surface, where a simple ablation model introduces mass at a rate determined by that flux. The internal structure and dynamics of the arc induced by that wall interaction are described including the plasma velocity field, the current distribution, and profiles of the magnetic field, plasma density and temperature.

21029 Beam injection and transport experiments with an upgraded injector in the UNM betatron. Siergiej, D.M. (New Mexico Univ., Albuquerque, NM (USA). Dept. of Electrical and Computer Engineering); Schamiloglu, E.; Terry, R.L.; Humphries, S. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

A study of the injection and transport of a high-power relativistic electron beam (130 A, 300 keV) in the UNM betatron was recently concluded. The electron beam was injected at an angle of 20^0 with respect to the main axis of the accelerating ring. An electrostatic inflector provided a transverse electric field as large as 1.2 MV/m to bend the beam onto the main axis of the machine. A periodic solenoidal lens array was used for strong focusing of the relativistic beam. An electron beam current of 15 A was transported around the entire accelerating ring. These experiments verify that a transverse electric field could be used to bend an externally injected relativistic electron beam onto the main axis of the accelerating ring and the injected beam could be transported in the periodic solenoidal lens array. A large fraction of electron beam current was lost during injection and transport. In order to remedy this, the Marx generator is being upgraded to 600 kV and a crowbar system is being installed. The upgraded injector should result in a small spread in electron beam energies and larger total injected electron beam current. This modification should result in the transport of beam currents on the order of 100 A around the accelerating ring. The authors describe the upgraded Marx injector with the novel crowbar and present results of beam injection and transport experiments with the new injector.

21030 Self-focusing of laser beams in magnetized relativistic electron beams. Whang, M.H. (Polytechnic Univ., Farmingdale, NY (US)); Ho, A.Y.; Kuo, S.P. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184--: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Recently, there is considerable interest in radiation focusing and optical guiding using the resonant interaction between the radiation field and electron beam. The result of radiation focusing has been shown to play a central role in the practical utilization of the FEL. This result allows the device to use longer interaction length for achieving higher output power. Likewise, the possibility of self-focusing of the laser beam in cyclotron resonance with a relativistic electron beam is also an important issue in the laser acceleration concepts for achieving high-gradient electron acceleration. The effectiveness of the acceleration process relies strongly on whether the laser intensity can be maintained at the desired level throughout the interaction. In this work, the authors study the problem concerning the self-focusing of laser beam in the relativistic electron beams under the cyclotron auto-resonance interaction. They assume that there is no electron density perturbation prohibited from the background magnetic field for the time scale of interest. The nonlinearity responsible for self-focusing process is introduced by the energy dependence of the relativistic mass of electrons. The plasma frequency varies with the electron energy which is proportional to the radiation amplitude. They then examine such a relativistic nonlinear effect on the propagation of a Gaussian beam in the electron beam. A parametric study of the dependence of the laser beam width on the axial position for various electron beam density has been performed.

21031 Characterization of a 1-μs, 1-MA plasma erosion opening switch. Commisso, R.J. (Naval Research Lab., Washington, DC (USA). Plasma Physics Div.); Boller, J.R.; Grossmann, J.M.; Hinshelwood, D.D.; Kellogg, J.C.; Mosher, D.; Ottinger, P.F.; Weber, B.V. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184--: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The plasma erosion opening switch (PEOS) has been used on a variety of state-of-the-art pulsed power generators that employ conventional, capacitive power conditioning techniques to enhance their power delivery capability. In these applications, the PEOS has conducted up to several megamperes of current in $\simeq$ 100 ns and opened in $\simeq$ 10 ns. The utility of the PEOS for pulsed power applications increased significantly by extension of the conduction time to the $\simeq$1 μs regime at high currents ($\simeq$1 MA). In these inductive power conditioning experiments either a fast capacitor bank or a fused, slower capacitor bank is used to drive a PEOS that conducts up to 1 MA in $\simeq$ μs and opens in < 100 ns. An important factor that could limit the PEOS conduction time is the PEOS plasma displacement resulting from JxB forces. The long conduction time must be achieved while satisfying the requirement that the PEOS open rapidly ($\leq$ 100 ns) into a resistive load. Experiments are described that characterize the conduction phase of a PEOS driven by a fused capacitor bank. Results as well as detailed measurements of the PEOS current distribution are presented.

21032 Anomalous transport in tokamaks. Wootton, A.J. (Texas Univ., Austin, TX (USA). Fusion Research Center). pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184--: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

A review is presented of what is known about anomalous transport in tokamaks. It is generally thought that this anomalous transport is the result of fluctuations in various plasma parameters. In the plasma edge detailed measurements of the quantities required to directly determine the fluctuation driven fluxes are available. The total flux of particles is well explained by the measured electrostatic fluctuation driven flux. However, a satisfactory model to explain the origin of the fluctuations has not been identified. The processes responsible for determining the edge energy flux are less clear, but electrostatic convection plays an important part. In the confinement region experimental observations are presently restricted to measurements of density and potential fluctuations and their correlations. The characteristics of the measured fluctuations are discussed and compared with the predictions of various models. Comparisons between measured particle, electron heat and ion heat fluxes, and those fluxes predicted to result from the measured fluctuations, are made. Magnetic fluctuations is discussed.

21033 On the so-called first-order magnetic pumping by sawtooth-waveform magnetic variations. Borovsky, J.E. (Space Plasma Physics Group, Los Alamos National Lab. (US)); Hansen, P.J. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184--: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

A periodic sawtooth wave consists of a slow ramp up followed by a fastdrop down. The heating of plasmas by sawtooth-waveform magnetic-induction variations is examined with the use of analytic solutions to the magnetic-pumping problem, numerical solutions to a pair of coupled partial differential equations that describe magnetic pumping, and computer simulations of magnetically pumped plasmas. The sawtooth variations are divided into two classifications: adiabatic-drop sawtooths in which the first adiabatic invariants of the plasma particles are conserved during the drops and ultrafast-drop sawtooths in which the first adiabatic invariants are not conserved during the drops.

21034 Operation of an intense ion beam diode at high repetition rate. Noonan, W.A. (Cornell Univ., Ithaca, NY (USA). Lab. of Plasma Studies); Glidden, S.C.; Greenly, J.B.; Hammer, D.A.; Jain, K.K.; Qi, N.; Brissette, L. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184--: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

A magnetically insulated ion diode with a plasma anode has been operated on a pulsed power system capable of up to 1 kHz repetition rate in bursts of a few pulses. In this paper, the authors present diode operating characteristics as a function of anode plasma parameters and insulating magnetic field strength. Results on ion beam extraction in single shot mode, at 1/3 Hz and at higher repetition rate are discussed.

21035 Progress in high power millimeter-wave FELs with short period wigglers and sheet electron beams. Booske, J.H. (Maryland Univ., College Park, MD (USA)); Radack, D.J.; Antonsen, T.M.; Bidwell, S.; Destler, W.W.; Granatstein, V.L.; Latham, P.E.; Levush, B.; Mayergoyz, I.D.; Serbeto, A. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184--: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The authors report on the status of their program to develop a high average power millimeter-wave FEL using a short-period wiggler and a sheet electron beam. Results on the transmission of wiggler-focused sheet beams through narrow waveguide gaps are presented, including detailed theoretical simulations and experimental measurements of body currents. They describe FEL design improvements yielding negligible rf wall losses and substantially reduced body currents. In addition, recent achievements in wiggler magnet development and two proof-of-principal FEL experiments are discussed.

21036 Laboratory experiments and computer simulations of the interaction of plasmas with rapidly charged objects. Borovsky, J.E. (Space Plasma Physics Group, Los Alamos National Lab. (US)). pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184--: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The temporal nature of the particle fluxes to conducting objects that are placed in low-density plasmas and then subjected to fast voltage pulses are studied. Experimental measurements of the plasma return current are compared with theoretical predictions and with estimates of the currents obtained from particle-incell computer simulations. By means of the computer simulations, the temporal nature of the kinetic-energy distribution of plasma electrons and ions striking the rapidly biased objects is examined. Likewise, by means of computer simulations and laboratory experiments, the perturbations to the plasmas by the rapidly charged objects is studied. These perturbations include density cavity formation very near the objects caused by particle absorption and particle acceleration and cavitation away from the objects driven by the oscillating two-stream instability.

21037 Laboratory model of wave/current wings launched by rapidly moving conductors in magnetoplasmas. Stenzel, R.L. (California Univ., Los Angeles, CA (USA). Dept. of Physics); Urrutia, J.M. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The current systems set up by charged conductors moving rapidly through a magnetized plasma presents a problem of fundamental interest in space and laboratory plasmas (electrodynamic tethers, large space stations, beam injections, railguns, etc.). Classical theoretical models predict that the current collected/emitted by a moving electrode will flow along a wing-like structure due to the combined motion of the electrode across B_o and the current propagation along B_o by Alfven waves (Alfven wings). First laboratory experiments on the penetration of currents in magnetized plasmas revealed that rapid current perturbations from small-scale electrodes propagate at the electron whistler wave speed rather than the Alfven speed. The work reported in this paper extends the investigation of stationary electrodes with pulsed currents to the caser of an electrode moving rapidly across B_o and collecting effectively a dc current.

21038 BOLVAPS/LIBORS experiments on PBFA-II. Renk, T.J. (Sandia National Labs., Albuquerque, NM (USA)); Johnston, R.R.; Dreike, P.L.; Tisone, G.C.; Maenchen, J.E. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). DOE Contract AC04-76DP00789. (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

BOLVAPS/LIBORS lithium ion source experiments are described in this paper. They have as a goal the development of a preformed lithium anode plasma layer from which an ion beam can be generated immediately upon arrival of the generator power pulse. Besides providing a relatively pure, high density lithium plasma on the anode surface, this approach may improve the power coupling from the generator. This is because a small amount of gas or plasma will span the A-K gap, possibly leading to a low impedance phase of the applied B ion diode, instead of the normally high initial impedance. The authors report on the changes made to the center of PBFA-II to accommodate this experiment. All the new subsystems were successfully implemented and tested on the accelerator. Subsequent generator shots are discussed.

21039 A device for producing uniform plasmas for advanced accelerator experiments. Kirkman, G. (University of Southern California, Los Angeles, CA (USA). Dept. of Electrical Engineering); Figueroa, H.; Gundersen, M.A. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The authors report the development of a device that produces uniform plasmas of density 10^{14} 10^{15} cm^{-3} over volumes ≥ 1 cm^3, and discuss applications for the realization of plasma lens and plasma accelerator experiments. The device is based on a high current hollow cathode pulsed discharge that has demonstrated a uniform, repeatable plasma that may be operated at high repetition rates with low energy storage and dissipation. Applications to be discussed include a plasma lens that is proposed for the final focus of electron-positron colliders. The device can produce active focusing due to the magnetic field produced by the high current plasma, and self focusing resulting from space charge neutralization. Calculations appropriate to the focusing of 20 Mev and 50 Gev electron beams are presented. A calculation of the fields produced by the plasma device and their relation to plasma-based accelerator experiments are discussed.

21040 Plasma sheath modeling near an ICRF Faraday shield. Whealton, J.H. (Oak Ridge National Lab., TN (USA)); Raridon, R.J.; Ryan, P.M. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). DOE Contract AC05-84OR21400. (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

In this paper, the Vlasov-Maxwell equations in Lorentz gauge and a quasi-electrostatic limit are considered on ion time scales in 4-6-D, subject to boundary conditions and volume conditions. The sheath physics near a Faraday shield is studied under this formulation. Scenarios and conditions affecting metallic impurity generation are the focus of this study.

21041 RF discharge experiment for modifications of organic molecules. Ampela, M. (Rensselaer Polytechnic Institute (USA)); Smith, D.; Connor, K.A.; Woo, J.T. pp. 160 of Conference record of the 1988 IEEE international conference on plasma science (abstracts). IEEE Service Center, Piscataway, NJ (1988). (CONF-880651–: IEEE international conference on plasma science, Seattle, WA (USA), 6-8 Jun 1988).

Technical Paper 3P10.

The authors describe a discharge experiment built to study energy efficient breakdown of organic molecules found in toxic wastes. A 3.5 MHz, 2 kW rf power supply is used to create a steady state discharge in a simple vacuum system constructed of both glass and metal. Power is coupled to the plasma by a 3 turn coil wrapped around the main glass chamber. A mechanical vacuum pump maintains 10 mTorr. Operating pressures are in the range of 10 to 800 mTorr. Reaction products are collected in a liquid nitrogen trap between the pump and the chamber. A residual gas analyzer chamber is attached through an adjustable differential pumping orifice so that the necessary lower pressures can be maintained for the electron emitter. This auxiliary tank is separately evaluated by a combination of diffusion and mechanical pumps. The RGA is used to determine the composition of the background gas before and after the discharge. Plasma density, temperature and potential profiles are determined with Langmuir probes.

21042 Initial operation and experiments in the Advanced Toroidal Facility (ATF). Glowienka, J.C. (Oak Ridge National Lab., Oak Ridge, TN (USA)). pp. 160 of Conference record of the 1988 IEEE international conference on plasma science (abstracts). IEEE Service Center, Piscataway, NJ (1988). DOE Contract AC05-84OR21400. (CONF-880651–: IEEE international conference on plasma science, Seattle, WA (USA), 6-8 Jun 1988).

Technical Paper 1P9.

The Advanced Toridal Facility (ATF) is a moderate aspect ratio, 1 = 2, m = 12 torsatron. Upon completion of construction, a series of system integration tests or device commissioning began to bring all systems to full operating capability. Results of radiation surveys indicate that radiation levels in ATF are small: the worst-case personnel dose is 2mR per machine pulse with the suppressions system deliberately inhibited. Plasma diagnostics were installed to assess whether the plasma created by ECH was suitable for neutral beam injection (NBI). This diagnostic set included a bolometer, an H-Alpha monitor, the hard X-ray monitor, a 2mm single-channel interferometer, a CCD camera, a soft X-ray pulse-height analyzer, and a Residual Gas Analyzer. This paper reports the data obtained about machine performance during commissioning and about the plasma performance obtain during the initial operating period.

21043 2-D magnetohydrodynamic model for a dense helium plasma focus. Begay, F. (Los Alamos National Lab., NM (USA));

Lindemuth, I. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Results from the two-dimensional, two-temperature computer code MHRDR (magneto-hydro-radiative-dynamics research) which describes the performance of a dense plasma focus device are presented. These calculations represent the first analysis of a helium plasma produced in a dense plasma focus device. Results from a comparative analysis of the data from the model and the experiment are discussed.

21044 Development of KrF lasers for inertial confinement fusion. Figueira, J.F. (Los Alamos National Lab., Los Alamos, NM (US)); Rosocha, L.A.; Sorem, M.S.; Harris, D.B. pp. 203 of High power and solid state lasers II. Dubie, G SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (1989). (CONF-890157–: 2. conference on high power and solid state lasers, Los Angeles, CA (USA), 19-20 Jan 1989).

High peak power rare gas halide lasers for applications in inertial confinement fusion are being developed at laboratories across the world. This paper focuses on a U.S. Department of Energy program conducted at the Los Alamos National Laboratory and the Naval Research Laboratory. The Los Alamos laser development program is composed of three major elements; the Aurora Laser Facility is a 1 terawatt KrF laser designed as an integrated performance demonstration of a target qualified excimer laser system; an advanced design effort evaluates concepts that offer the improved performance and lower cost that will be essential for the construction of future lasers in the 0.5 to 10 MJ class; and a laser technology program that addresses both performance and cost issues that will be important in advanced laser system designs.

21045 X-ray laser research at Physics International. Nash, T. (Physics International Co., San Leandro, CA (USA)); Deeney, C.; Levine, J.; LePell, P.D.; Krishnan, M. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Photopumped and recombination X-ray laser schemes are under investigation at Physics International, on the DNA/PITHON 3 TW facility. For the sodium-neon resonant photopumped scheme, DNA/PITHON is used to implode a sodium-bearing plasma, the pump, and a secondary capacitor bank is used to drive a neon gas puff Z-pinch, the lasant. The characterization of the pinched sodium plasma is reported in this paper, as are pump power measurements, which showed 65 GW in the Na X $1s^2$-$1s2p$ ^{1}p.line.

21046 Preliminary plasma focus driven DT microballoon experiments. Freeman, B.L. (Los Alamos National Lab., NM (USA)); Rickel, D.G. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Results have been obtained from initial experiments in which a small plasma focus was used to drive DT microballoons. The DT microballoons were 1 mm in diameter and contained 75 atmospheres of DT gas in 50% mixture. The plasma focus driver achieves a maximum current of ~1 MA from its 20-kV, 72-kJ capacitor bank. The plasma sheath was formed from deuterium, helium, and argon for these tests. After several conditioning shots using the gas for the experiment, the microballoons were inserted into the focus region through an air lock in the device's anode, to avoid any electrical gradient between the positive electrode and the target. The results of these tests are presented.

21047 Computational modelling of compact toroidal plasmas. Clouse, C.J. (Air Force Weapons Lab. (US)); Baker, W.L.; Beason, J.D.; Degnan, J.H.; Dietz, D.; Rowley, J.E.; Sovinec, C.R.; Buff, J.S.; Frese, M.H.; Peterkin, R.E. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Preliminary simulations of the formation of compact toroids are presented. This work is in support of current experiments in which compact toroids - a minimum magnetic energy configuration with linked toroidal and poloidal flux - are being formed, accelerated and compressed. Simulations were performed using MACH2, a 2D magnetohydrodynamic code with a newly implemented Van Lear transport scheme. Simulations also include a detailed modelling of the initial poloidal flux distribution produced by the external solenoidal coils, which is through to significantly effect the toroid's formation.

21048 The intense electron-beam-driven elementary monotron. Walsh, J. (Dartmouth Coll., Hanover, NH (USA)); Dong, L.; Arman, M.; Godfrey, B.; Mostrom, M.; Sullivan, D. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The basic monotron is an electron-beam driven single-cavity, single-pass regenerative oscillator. When driven by an intense, relativistic electron beam they are potentially important sources of intense microwave radiation. Operating efficiency in the 12-25% range appears to be possible in principle and thus considerable power can be extracted from a pulse-power-driven monotron. A general theory of the linear and nonlinear characteristics of this device has been developed. Based on single-particle dynamics and the complex version of Poynting's theorem the theory is capable of predicting the gain, the saturation level, the efficiency and the sensitivity of performance-to-beam quality for any source of the monotron type. Although based on single-particle dynamics, the theory is applicable in the intense beam limit since the devices have a short length. Further, if required, the effects of beam self-fields and space charge can be included. An outline of the theory and application to specific examples are presented.

21049 Confined discharge plasma sources for Z-pinch experiments. Hinshelwood, D.D. (JAYCOR, Vienna, VA (USA)); Goodrich, P.J.; Mehlman, G.; Scherrer, V.E.; Stephanakis, S.J.; Young, F.C.; Welch, B.L. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The authors report their investigation Z-pinch implosions on the NRL Gamble II generator using metallic sources of sodium and aluminum, and non-metallic source of sodium (NaF), magnesium (MgF_2), and aluminum (Al_2O_3). For 1 MA driving currents, peak K-shell radiated powers of about 100 GW and energies of about 1.5 kj have been obtained with both pure aluminum and NaF implosions. The aluminum results are comparable to those in previous Gamble II experiments with aluminum wire arrays. Confined discharge sources have been used to generate tens of GW in the Na Heα pump line and flourescence of the neon has been observed. The effects of nozzle shape and size, chamber diameter, amount of fuse material, and confined discharge current have been investigated in Gamble II implosion experiments. These studies indicate that confined discharge sources are capable of supplying significantly more material than required for implosions at the 1 MA level, so that this technique could be extended to higher current generators.

21050 Two-dimensional long pulse calculations of electron layer formation in crossed microwave beams in low pressure air. Mayhall, D.J. (Lawrence Livermore National Lab., CA (USA)); Yee, J.H.; Sieger, G.E.; Alvarez, R.A. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). DOE Contract W-7405-ENG-48. (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Laboratory chamber experiments in low pressure (0.1-10 Torr) air with long pulse (100-600 nsec), 2.856 GHZ crossed microwave beams formed by reflection of a single beam from an inclined metal

plate have shown that multiple, luminous electron density layers form sequentially in time toward the source of the incident beam. For modeling of this experiment, a two dimensional (2d), long pulse electron fluid computer code has been developed. Initially, the electron evolution in the 2d, rectangular, x-y space transverse to the driving E_Z microwave field is described by a convective continuity equation. The convection is approximated by electric drift and thermal diffusion terms in the x and y directions. The electron drifts are caused by electrostatic fields calculated from zero magnetic field approximations to the magnetic Maxwell curl equations with steady state conductivities. The avalanche ionization rate is included in the continuity equation as a function of air pressure and driving field amplitude and frequency. Calculations are done at 1 Torr pressure with a linearly ramped pulse, which reaches a plateau value of 0.159 MV/m at 80 nsec. Graphical output from these calculations are compared with experimental luminosity patterns. Calculated and experimental layer formation times are compared.

21051 Laser-produced plasmas in medicine. Gitomer, S.J. (Los Alamos National Lab., NM (USA)); Jones, R.D.; Howsare, C. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The laser has found applications in medicine, beginning with uses in ophthalmology in the 1960's. Today, lasers find medical applications in tissue cutting, blood coagulation, photodynamic cancer therapy, arterial plaque removal, dentistry, etc. In this paper, the authors examine the characteristics of plasmas which are produced in laser medicine. In particular, they consider the examples of plasmas produced in laser-lithotripsy (stone ablation and fragmentation by dye lasers) and in ocular photodisruption (lens membrane destruction by Nd:YAG lasers following cataract surgery). Experimental data is presented along with hydro-code simulations of the phenomena. The authors find that the simulations and experiments are in relatively good agreement with regard to plasma temperature, density, pressure, optical emission and evolution of cavitation bubbles.

21052 Plasma lenses. Brueckner, K.A. (California Univ., San Diego, La Jolla, CA (USA). Dept. of Physics); Mark, J.W. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

A charge-neutralized heavy ion beam may be focused on a target by the use of a plasma lens in which the magnetic field acts directly on the neutralizing electrons which in turn provide electrostatic focusing for the ions. A simple analysis shows that such a lens can be effective at relatively low magnetic field strengths and a short focusing region. The lens is, however, subject to two important aberrations which can increase the beam emittance and spread the focus. These are the diamagnetism resulting from the high azimuthal electron current in the lens and the relativistic increase in electron mass which changes the electron current variation with radius. The two effects, however, act in opposite directions, the diamagnetism being most pronounced at small radii while the current reduction due to the relativistic mass increase being greatest at large radius. In first approximation, both effects vary quadratically with radius and will cancel for proper choice of parameters. As an example, for a beam of 10 GeV lead ions of charge 3, a particle current of 30 kA carried by many beams, an initial radius of 5 cm, and a magnetic field of 400 G, the two effects cancel for 58 beams, giving a perfect focus to this order of correction. The results of more complete analytic and computational study are presented.

21053 A self-similar modeling and transport analysis of laser-produced coronas. Kim, K. (Illinois Univ., Urbana, IL (USA). Dept. of Nuclear Engineering); Choe, W.H. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

A laser-produced plasma in the underdense region ($n \simeq n_c$) is known to be well described by the isothermal expansion model. However, most previous work did not include the effects of the self-generated magnetic field (– a few MG), which is supposed to profoundly affect the physical behavior of laser-produced plasmas. In this work, the previous isothermal expansion model is extended to include the effects of the self-generated magnetic field. Location of the critical density surface is assumed to determined exclusively by adiabatic expansion of the overdense region, but the overdense and the underdense solutions are matched across the critical density surface. The model is used to study hot electron transport in the presence of the self-generated magnetic field.

21054 Dynamics of sheaths in low pressure R.F. discharges. Lieberman, M.A. (California Univ., Berkeley, CA (USA)). pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Low pressure r.f. discharges are widely used for materials processing. Typical parameters are pressure 1-100 mTorr, frequency 13.56 MHz, and r.f. voltage 50-1000 V. Almost all the applied voltage is dropped across capacitive sheaths at the discharge electrodes or wall surfaces. Hence, the sheaths control the power deposition in discharge. A reasonably complete picture of the dynamics of these sheaths has been developed. The author reviews what is known, drawing from analyses, experiments, and computer simulations. Topics described include sheath thickness, capacitance and conductance, d.c. bias and harmonic voltage generation, stochastic heating by the oscillating sheath, and the effects of low r.f. driving voltage, time-average electron space charge, and ion collisions within the sheath. Applications to non-symmetric discharges, having electrodes with unequal areas are described.

21055 Analysis of multiple-foil XRL targets using x-ray spectroscopy. Wang, J. (Rochester Univ., NY (USA). Lab. for Laser Energetics); Boehly, T.; Yaakobi, B.; Epstein, R.; Meyerhofer, D.; Richardson, M.C.; Russotto, M.; Soures, J.M.; Shvarts, D. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The multiple-foil collisional excitation x-ray laser targets proposed by LLE have been studied spectroscopically. Using spatially resolved 3d-2p x-ray spectra, the authors compare the temperatures and densities obtained in single- and double-foil geometries. They use the ratio of the dipole transitions to the electric quadrupole transitions in the Neon-like species as a density diagnostic. A non-LTE average-ion atomic physics model is used to describe the ionization process and a relativistic atomic physics code is used for calculation of the level energies, populations, and gain calculations. They support their claims that the double-vfoils provide higher densities and in some cases concave density profiles. The XUV spectra in the range of 20-300 A show the effect of target geometry and incident laser intensity on the lasing lines and the ionization balance.

21056 Numerical simulation of ECR microwave plasma stream. Hussein, M. (Wisconsin Univ., Madison, WI (USA). Dept. of Nuclear Engineering and Engineering Physics); Emmert, G.A. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The authors have simulated an ECR microwave plasma stream along a moderate gradient magnetic field. The magnetic flux density decreases gradually from the ECR region in the plasma chamber towards the specimen table. The simulation is kinetic in which ions are assumed to flow collisionlessly along the field line while electrons are considered collisional enough for the Boltzmann relation to be valid. A Monte Carlo description for the ion dynamics, coupled with Boltzmann electrons are used to develop an

iterative scheme for the Vlasov equation and quasi-neutrality. The effects of the mirror field on the electrostatic potential profile along the magnetic field line and the energy distribution of the ions incident on the specimen are presented.

21057 Demonstration of efficiency enhancement in a high power backward wave oscillator by plasma injection. Carmel, Y. (Maryland Univ., College Park, MD (USA). Lab. for Plasma Research); Destler, W.W.; Granatstein, V.L.; Minami, K.; Abe, D.; Lou, W.R.; Kehs, R.A. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

An experimental demonstration of a strong enhancement of the interaction efficiency in a high power relativistic backward wave oscillators when plasma is injected is presented. Plasma injection enhances the interaction efficiency by a factor of up to 8 to a value of about 40%. Overdriving the device with plasma above a critical density quenches the interaction. It is anticipated that plasma injection may prove beneficial in other high power microwave and millimeter devices such as free electron lasers and gyrotrons. The enhanced interaction is attributed to induced scattering of the electromagnetic radiation of electrons in an electrostatic field produced by the background plasma and a beam space charge wave in the corrugated interaction region.

21058 Performance of laser activated semiconductor opening switches. Chauchard, E.A. (Maryland Univ., College Park, MD (USA). Dept. of Electrical Engineering); Kung, C.C.; Lee, C.H.; Rhee, M.J. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Laser activated semiconductor switches utilize instantaneous response of photoconductivity to turn on or turn off the current through the switch. It has been shown that the semiconductor switch is a good candidate for the fast opening switch applications. With a suitable choice of switch material, for which the carrier recombination time is very fast, the opening time can be as fast as subnanosecond with a very high repetition rate. The semiconductor switches can easily sustain a large voltage and conduct a high current. The authors report on the performance of high voltage operation of GaAs switches. The switches used were intrinsic GaAs and Cr: GaA of bulk devices of millimeter sizes. The range of bias voltage applied was 500 V to 2 kV. The light source was a Q-switched Nd:YAG laser with 10 ns pulse duration. The closing and opening speeds of the Cr:GaAs switches were limited by the rise time and fall time of the laser pulse. Typical off-resistances when the laser light illumination was turned off is higher than 20 MΩ, whereas the on-resistances with laser illumination can be as low as 1 Ω. Such a large ratio of off-resistance to on-resistance allowed switching efficiency of better than 99%.

21059 The dense Z-pinch as a fusion power source. Sethian, J.D. (Naval Research Lab., Washington, DC (USA)); Robson, A.E.; Gerber, K.A.; DeSilva, A.W. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Previous experiments have shown that a dense z-pinch formed from a frozen deuterium fiber and driven with a rapidly rising current from a high-voltage pulse generator are unexpectedly stable. This is in direct contrast with the predictions of simple MHD theory. In one experiment, the pinch stability is maintained as long as the current is rising, and is lost as soon as the current peaks. Since the fiber pinches appear very close to pressure equilibrium, one can estimate the temperature of the pinch from the Bennett relation, $I^2 = 4NkT$. At 640 kA, this corresponds to a temperature of 200 eV, which is not hot enough for the pinch to produce a significant number of thermonuclear reactions. However, if the pinch stability can be maintained at higher currents, say 2 MA, then it can be shown from simple zero-d models that the pinch could achieve thermonuclear breakeven. The authors discuss how, to achieve these higher currents, they have constructed a generator called ZFX that will be capable of driving up to 2 MA through the pinch.

21060 High energy density fusion using the Compact Torus. Eddleman, J.L. (Lawrence Livermore National Lab., CA (USA)); Hammer, J.H.; Hartman, C.W.; Logan, B.G.; Moir, R. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). DOE Contract W-7405-ENG-48. (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The authors discuss how their use of the Compact Torus (CT) magnetic field configuration to produce fusion energy in high energy density regimes where the pressures generated extend well beyond the strength of materials. Under such conditions, nearby walls which provide inertial tamping are vaporized and pushed aside each shot. Spherical plasma scaling is considered for initial plasma-field energies of 10 and 100 MJ. The possibility of a high energy density fusion reactor with destructible walls has been noted previously. What is new, is a low-cost driver for forming high-energy-density CT's at high efficiency and on the timescale of the application discussed here.

21061 Interaction of an intense relativistic electron beam with a plasma-filled waveguide in a magnetic field. Poole, B.R. (Lawrence Livermore National Lab., CA (USA)); Chong, B.; Camacho, J.F. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). DOE Contract W-7405-ENG-48. (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Analytic computations and PIC code simulations for the interaction of an intense relativistic electron beam and a plasma are presented. In their simulations, a fast rise time (– 5 ns) 10 kA REB (1 MeV) is injected into a plasma-filled waveguide immersed in an axial magnetic field. Beam transport and microwave generation by beam-plasma instabilities are investigated in both the infinite and finite B field cases. In the finite B field case, both the two-stream and cyclotron instabilities are important. Calculations of charge and current neutralization of the REB are performed in the intense beam regime. These calculations provide the appropriate parameters for the linear dispersion relation to the system. This dispersion relation is solved to determine the nature of the instabilities; i.e., their microwave spectra and growth rates.

21062 MHD instabilities in TEXT discharges with high magnetic perturbation levels and ergodic magnetic limiter effects. Chen, J.Y. (Institute of Plasma Physics, Hefei (CN)); Foster, M.S.; McCool, S.C.; Wootton, A.J.; Yang, X.Z.; Yu, X.H.; Brower, D.L.; Schoch, P.M. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The authors report non-disrupting, high MHD discharges investigated on TEXT. The MHD instability has been studied over a wide range of q_a for this types of discharge. Three diagnostic systems are used to explore the internal mode structure of the perturbation: two soft x-ray arrays to provide tomographic data; a 36 channel FIR interferometer, and a heavy ion beam probe. The results are discussed. With the aid of a non-linear toroidal MHD code considering the ergodic magnetic limiter perturbation and a measurement of the radial electric field, inside the plasma, a comparison is made between modeled results and experimental data.

21063 Foil implosion studies with a plasma flow switch. Bartsch, R.R.; Cochrane, J.C.; Begay, F.; Kruse, H.W.; Oona, H.; Parker, J.V.; Turchi, P.J. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

A plasma flow switch has been developed for the 1.5 MJ Pegasus capacitor bank to efficiently utilize the bank energy to drive a foil implosion. The object of this activity is to generate an intense

burst of soft x-rays when the foil stagnates and thermalizes on axis. The peak current of the Pegasus bank, determined from the charge voltage divided by the characteristic impedance of the capacitor bank is – 10 MA. When used to perform direct-drive, foil implosion experiments, the foil collapses to the axis when the current has risen to only – 3 MA. The kinetic energy of the imploding foil for the direct-drive configuration cannot exceed – 25% of the bank energy (lossless calculation). The plasma flow switch has been designed to have a conduction time of – 4 μsec and a commutation time of – 0.2 μsec. This permits flow implosion experiments to be performed at peak current. The soft x-ray output, as determined by volometry and by an array of filtered x-ray diodes, is compared for the two modes of operation.

21064 Computer simulations of a reflex triode. Ambrosiano, J. (Berkeley Research Associates, Springfield, VA (USA)); Geary, J.L. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

A reflex triode can achieve a low-impedance state with higher current and lower voltage than an ordinary diode with the same anode-cathode spacing. Because its lower impedance is the result of reflexing electrons, it is possible to switch between low and high impedance states by altering the electron population. The authors have built a special-purpose computer code to study details of the reflex triode in one-dimension. They present simulations of a reflex triode as it approaches the low-impedance conduction phase. The simulations show evidence of viractor-like oscillations as well as a Pierce-type instability in certain parameter regimes. This instability violently disrupts the current in some cases.

21065 Neutral accumulation from plasma-wall interactions in plasma opening switches. Chen, L.L. (Berkeley Research Associates, Springfield, VA (USA)); Geary, J.L. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The effects of contaminants on the electrodes of plasma opening switches (POS) are studied. These contaminants introduce backscattered and sputtered neutral atoms into the carbon plasma that is impinging onto the cathode. This process is investigated with the TRIM.SP code. The distribution of density of these neutral atoms from the cathode surface is obtained and found to be substantial when compared to the density of the incident carbon plasma. The dependence of the sputtering yield on the composition of the contaminants is also studied.

21066 Small-signal theory of the high-power magnetron with intense electron flow. Stark, R.A. (Naval Surface Warfare Center, Silver Spring, MD (USA)); Uhm, H.S. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

In the work presented here, the authors have modified a linear stability analysis of the planar magnetron with intense electron flow to describe the case of a cylindrical magnetron. The eigendifferential equation for extraordinary mode oscillations is solved numerically over a range of parameters characterizing the electron flow and the magnetron geometry. The effect of the anode resonators is imposed through the boundary condition at the outer radius of the electron flow. Both the magnetron instability (doppler-shifted electron cyclotron resonance) and the diocotron instability are observed. Implications for the start-up of existing experimental high-power magnetrons will be presented.

21067 A Hall-current model of electron loss after POS opening into high-impedance loads. Greenly, J.B. (Cornell Univ., Ithaca, NY (USA). Lab. of Plasma Studies). pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The author discusses how a self-consistent relativistic model of laminar Hall (E x B) electron flow across a POS plasma allows a loss mechanism after opening even in a strongly magnetically-insulated line, downstream of the remaining POS plasma. Opening is assumed to occur at the cathode, either by erosion or push-back. The loss results only when a large voltage appears after opening into a high impedance load. Then the difference in potential between the plasma, which is near anode potential, and the cathode results in an axial component of E at the load end of the plasma, which supports an E x B drift of electrons across the gap. The analytic model predicts that this loss should increase with higher voltage after opening, and could be eliminated only by removing the plasma from the gap, or eliminating cathode electron emission (both difficult), or by confining this downstream electron flow with an applied magnetic field.

21068 Experimental investigation of plasma-neutralized operation of a gyrotron. Kirkpatrick, D.A. (Science Applications International Corp., McLean, VA (USA)); Sullivan, C.; Gold, S.H.; Manheimer, W.M.; Levush, B.; Antonsen, T.M. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The authors present plans and preliminary results of an experiment to investigate the effects of a neutralizing background plasma on the operation of a gyrotron oscillator. Previous experiments operating without a neutralizing background plasma achieved output powers P ≈ 100 - 250MW at a frequency f ≈ 35 GHz, with beam voltages in the range V ≈ 0.60 - 1.35MV, and beam currents I ≈ 1 -3kA. A completely ionized plasma is injected into a gyrotron interaction region from an upstream array of plasma guns. The peak plasma density available from the plasma guns exceeds $n_p > 10^{13}$ cm^{-3}. The plasma density is measured by 70 GHz microwave interferometry and Langmuir probes. A high current electron beam from a field emission electron gun enters the plasma-filled gyrotron cavity from the upstream side. The density of the neutralizing plasma is varied by changing the delay between the firing of plasma guns and the VEBA accelerator. The authors present measurements of the transmitted electron beam current. Subsequent design of a gyrotron oscillator which utilizes the enhanced capabilities are presented.

21069 A repetitively-pulsed, mobile, HPM systems. Spang, S.T. (AAI Corp., Hunt Valley, MD (USA)); Anderson, D.E.; Claborne, K.D.; Hill, R.A.; Manning, S.P.; Pasour, J.A.; Rexroad, D.M.; Scannell, E.P.; Williams, R.J.; Woodyard, D.A. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The AAI High Power Microwave (HPM) Source Development Program has been actively investigating the design of HPM test systems using relativistic magnetrons with a repetition rate capability. The design and test of a gigawatt level, S to C band, 10 Hz, mobile, relativistic magnetron, HPM system are discussed. The discussion focuses on the results of experiments to study mode competition, output coupling, frequency scaling and injection phase locking in relativistic magnetrons. In addition to the source development effort, advances in pulse power, antennas and instrumentation are discussed. The design of a second-generation mobile HPM system is discussed.

21070 IR laser absorption studies of radical concentrations in CF_4 RF plasmas. Wormhoudt, J. (Aerodyne Research, Inc., Billerica, MA (USA). Center for Chemical and Environmental Physics). pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Infrared tunable diode laser absorption studies of process plasmas are being carried out in a laboratory reactor which allows a long absorption path. In this paper the authors report studies of CF_4 radio frequency plasmas. For these studies, the reactor had an absorption path length of about 38 m. The electrodes were shielded from the plasma by a teflon liner. Results to date show a strong dependence on the properties of the reactor surfaces.

21071 **Cyclotron autoresonance maser amplifier experiments at M.I.T.** Bekefi, G. (Research Lab. of Electronics and Plasma Fusion Center, Massachusetts Institute of Technology, Cambridge, Massachusetts (US)); Danly, B.G.; Davies, J.A.; DiRienzo, A.; Leibovitch, C.; Pendergast, K.D.; Temkin, R.J.; Wurtele, J.S. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184--: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The authors discuss two studies of cyclotron autoresonance maser (CARM) amplifiers underway at M.I.T. They differ both in frequency and in the technologies employed. The 35GHz amplifier uses a 1.5MeV,260A,30ns electron beam from a field emission (explosive) cathode energized by a Marx type, Physics International Pulserad accelerator. The entire system is immersed in a uniform, pulsed magnetic field 7kG. Measurements give a small signal gain of 90dB/m, a saturated power output of 10MW and an electronic efficiency of 3%. The 140GH_z amplifier under development will employ a 450-700kV, 30A, 1μs electron beam from a Pierce-type gun driven by a high-voltage, long-pulse modulator. The magnetic field (~25kG) in the CARM interaction region will be produced by a superconducting magnet. Theoretical investigations of CARM efficiency, efficiency enhancement by magnetic field tapering, and amplifier stability are also being carried out.

21072 **Recent developments in x-ray laser research at LLE.** Boehly, T. (Rochester Univ., NY (USA). Lab. for Laser Energetics); Yaakobi, B.; Craxton, R.S.; Epstein, R.; Richardson, M.C.; Russotto, M.; Soures, J.M.; Wang, J.; Shvarts, D. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). (CONF-8905184--: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The authors present results and analysis of recent experiments using multiple-foil target designs for a collisional excitation x-ray laser in Ne-like nickel and germanium. These targets, which are designed to yield higher gains than single-exploding-foil targets, are irradiated by 600 ps pulses of 351 nm light in a single 18-mm line from GDL. The lasing lines at ~230 A are observed with a 1-m grazing incidence grating spectrometer. They discuss the relative merit of different pump-laser wavelengths and present experimental results for three wavelengths: 1.06 μm, 527 nm, and 351 nm. They present plans for the conversion of the GDL laser to a ~100 J - 10 ps laser (10 TW) which will be used for producing a recombinationally pumped laser in Al which is predicted to lase at 39 A. Results of computer simulation of these proposed experiments are presented.

21073 **Firing characteristics of a miniature laser-triggered high-voltage vacuum switch.** Earley, L.M. (Sandia National Labs., Albuquerque, NM (USA)); Scott, G.L.; Boettcher, G.E. pp. 180 of Proceedings of the 1989 IEEE international conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (1989). DOE Contract AC04-76DP00789. (CONF-8905184--: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The authors report the development of a miniature laser-triggered high-voltage vacuum switch with a fused KCl and Ni cathode. The switch uses metal-ceramic construction with a sapphire window in the anode to allow the laser beam to strike the cathode surface. Reliable triggering is achieved with only 20 to 40 μJ of laser energy. The switch was operated with a gap voltage ranging from 500 V to 3 kV with switching currents up to 5 kA peak. Switch life greater than one thousand shots without performance degradation has been observed on twenty-five prototype units.

21074 **A novel apparatus to investigate the possibility of plasma-assisted cold fusion.** Ruzic, D.N. (Illinois Univ., Urbana, IL (USA)); Schatz, K.D.; Nguyen, P.L. *Fusion Technology (USA)*, 16(2): 251-253 (Sep 1989).

Cold fusion of deuterium in a transition metal may have been demonstrated recently. These experiments use electro-chemical hydrolysis of heavy water to provide the fuel source and conditions for fusion. An alternate approach with some advantages over electrolysis is described. A dc plasma discharge is made in a deuterium gas with a negative electrode made of palladium. Independent pressure, temperature, and current control are also possible in this method. Detection of reactions is achieved by a charged-particle detector placed close to the back side of the cathode. To date, no fusion events have been seen. However, only a small portion of the available parameter space has been investigated.

21075 **Isotopic hydrogen fusion in metals.** Rogers, V.C. (Rogers and Associates Engineering Corp., Salt Lake City, UT (USA)); Sandquist, G.M. *Fusion Technology (USA)*, 16(2): 254-259 (Sep 1989).

Nuclear fusion between deuterons under ambient conditions has been observed in the metal cathode of an electrolysis cell with an electrolyte of heavy water. The evidence for the fusion reaction is derived primarily from the detection of a low level of 2.45-MeV neutrons presumably from the neutron branch of the deuterium fusion reactions. However, the estimated fusion energy yield associated with the neutron output is insufficient to account for the majority of the reported energy gain if the neutron-proton branch of the deuterium fusion reaction remains about equal to ambient conditions. The excess energy gain may arise from an unobserved chemical reaction or an unfamiliar nuclear reaction. Reported evidence of an excess of ^{4}He in the vicinity of the cathode may indicate that a ^{4}He branch from the deuterium fusion reaction reaction may proceed at ambient conditions through internal electron conversion without a large release of gamma rays. These issues are explored, and attempts are made to provide physical mechanisms and explanations for the cold fusion experimental observations.

21076 **Reactor prospects of muon-catalyzed fusion of deuterium and tritium concentrated in transition metals.** Stacey, W.M. Jr. (Georgia Inst. of Tech., Atlanta, GA (USA). Fusion Research Center (USA)). *Fusion Technology (USA)*, 16(2): 268-273 (Sep 1989).

It is conjectured that the number of fusion events catalyzed by a single muon is orders of magnitude greater for deuterium and tritium concentrated in a transition metal than in gaseous form and that the recent observation of 2.5-MeV neutrons from a D_2O electrolytic cell with palladium and titanium cathodes can thereby be interpreted in terms of cosmic muon-catalyzed deuterium-deuterium fusion. This suggests a new fusion reactor reactor consisting of deuterium and tritium concentrated in transition metal fuel elements in a fusion core that surrounds an accelerator-produced muon source. The feasibility of net energy production in such a reactor is established in terms of requirements on the number of fusion events catalyzed per muon. The technological implications for a power reactor based on this concept are examined. The potential of such a concept as a neutron source for materials testing and tritium and plutonium production is briefly discussed.

21077 **On the possibility of deuteron disintegration in electrochemically compressed D^+ in a palladium cathode.** Ragheb, M. (Illinois Univ., Urbana, IL (USA). Dept. of Nuclear Engineering (USA)); Miley, G.H. *Fusion Technology (USA)*, 16(2): 243-247 (Sep 1989).

The possibility of deuteron disintegration due to polarization in the coulomb field of a target nucleus according to an Oppenheimer-Phillips process is discussed within the context of electrochemically compressed D^+ in a palladium cathode. This reaction is possible between deuterons and palladium isotopes, as well as between the deuterons themselves. In the last case, the equivalent of the proton branch of the deuterium-deuterium fusion reaction occurs in preference to the neutron branch. The process provides a possible explanation for the observed energy release, tritium production, and neutron suppression in the Fleischmann and Pons experiment. If such a process can be experimentally verified,

analogous processes leading to the disintegration of the ^{9}Be nucleus may be achievable.

21078 Advanced energy conversion methods for cold fusion. Prelas, M.A. (Univ. of Missouri-Columbia, Nuclear Engineering Program, Fusion Research Lab., Columbia, MO (USA)). *Fusion Technology (USA)*, 16(2): 240-242 (Sep 1989).

If cold fusion is verified, then the next important question deals with how it can be used to produce energy. Several direct energy conversion concepts for use with cold fusion are discussed.

21079 Origin of the magnetic confinement force in the homogeneous Z pinch. Salingaros, N.A. (Univ. of Texas, Div. of Mathematics, San Antonio, TX (US)). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Plasma Science (USA)*, 17(6): 854-858 (Dec 1989).

This paper re-examines the basic assumptions about magnetic force and magnetic pressure in a pinch. The confinement of a plasma via its own internal magnetic field is analyzed in a cylindrical geometry. It is shown that there are subtle but serious ambiguities in the usual theory, which can be cleared up by elementary arguments. The results which follow lead to an improved understanding of the mechanism responsible for the Z pinch.

21080 A model for the operation of a laser-triggered vacuum low-inductance switch. Brannon, P.J. (Sandia National Labs., Albuquerque, NM (USA)); Riley, M.E. *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Plasma Science (USA)*, 17(6): 859-862 (Dec 1989). DOE Contract AC04-76DP00789.

A new model for the operation of a laser-triggered vacuum switch utilizing a composite target pellet in the cathode is given along with supporting experimental results. It is shown that two separate mechanisms are responsible for the operation of the switch; namely, a thermal mechanism for the initial current flow, and an ion regeneration mechanism for the current buildup.

21081 Extracted beam composition with a mixed isotope feed to a neutral-beam system. Grisham, L.R. (Princeton University Plasma Physics Laboratory, P.O. Box 451, Princeton, New Jersey 08543 (USA)); Falter, H.D.; Hemsworth, R.; Deschamps, G. *Review of Scientific Instruments (USA)*, 60(12): 3730-3733 (Dec 1989).

Both the Tokamak Fusion Test Reactor and the Joint European Torus, two large magnetic confinement fusion devices, will use high-powered tritium beams. The suggestion has been made that tritium consumption could be reduced if tritium is only fed into the plasma source and deuterium or hydrogen is used as the neutralization target by operating with deuterium or hydrogen fed independently into the neutralizer. We report on measurements we performed with deuterium and hydrogen, and of the beam contamination that occurs in such an operating mode.

21082 Temporal behavior of neutral particle fluxes in TFTR neutral beam injectors. Kamperschroer, J.H. (Princeton Plasma Physics Laboratory, Princeton University, P.O. Box 451, Princeton, New Jersey 08543 (USA)); Gammel, G.M.; Roquemore, A.L.; Grisham, L.R.; Kugel, H.W.; Medley, S.S.; O'Connor, T.E.; Stevenson, T.N.; von Halle, A.; Willi *Review of Scientific Instruments (USA)*, 60(12): 3721-3729 (Dec 1989). DOE Contract AC02-76CH03073.

Data from an E||B charge exchange neutral analyzer (CENA), which views down the axis of a neutral beamline through an aperture in the target chamber calorimeter of the TFTR neutral beam test facility, exhibit two curious effects. First, there is a turn-on transient lasting tens of milliseconds having a magnitude up to three times that of the steady state level. Second, there is a 720 Hz, up to 20% peak-to-peak fluctuation persisting the entire pulse duration. The turn-on transient occurs as the neutralizer/ion source system reaches a new pressure equilibrium following the effective ion source gas throughput reduction by particle removal as ion beam. Widths of the transient are a function of the gas throughput into the ion source, decreasing as the gas supply rate is reduced. Heating of the neutralizer gas by the beam is assumed responsible, with gas temperature increasing as gas supply rate is decreased. At low gas supply rates, the transient is primarily due to dynamic changes in the neutralizer line density and/or beam species composition. Light emission from the drift duct corroborate the CENA data. At high gas supply rates, dynamic changes in component divergence and/or spatial profiles of the source plasma are necessary to explain the observations. The 720 Hz fluctuation is attributed to a 3% peak-to-peak ripple of 720 Hz on the arc power supply amplified by the quadratic relationship between beam divergence and beam current. Tight collimation by CENA apertures cause it to accept a very small part of the ion source's velocity space, producing a signal linearly proportional to beam divergence. Estimated fluctuations in the peak power density delivered to the plasma under these conditions are a modest 3%–8% peak to peak. The effects of both phenomena on the injected neutral beam can be ameliorated by careful operation of the ion sources.

99 GENERAL AND MISCELLANEOUS

Refer also to citation(s) 19536, 19782

9901 Management

Refer also to citation(s) 19418, 19705, 20029, 20031, 20099, 20228

21083 (IAEA-TECDOC–525) **Guidebook on training to establish and maintain the qualification and competence of nuclear power plant operations personnel.** International Atomic Energy Agency, Vienna (Austria). Nov 1989. 572p. Order Number DE90617985. Available from NTIS (US Sales Only), PC A24/MF A01; OSTI; INIS.

Since the IAEA published its Guidebook on the Qualification of Nuclear Power Plant Operations Personnel in 1984 (Technical Reports Series 242) there have been important developments in the approach to training adopted by many operating organizations in different countries. It is now accepted that developing training programmes based solely on experience is inappropriate for the nuclear power industry, and that a systematic approach to training is necessary. It has been recognized that inadequate knowledge and skills may lead to human errors, and it is therefore necessary to review and improve the development and implementation of initial and continuing training programmes. The present Guidebook proposes an approach which is comprehensive and systematic in its methodology and also cost effective in its implementation. This Guidebook is mainly intended for management and training staff of nuclear power plant operating organizations. Relevant examples of current training practices are presented in the Appendices, which constitute an integral part of the Guidebook. Refs, figs and tabs.

21084 (ORNL/TM–10817) **Maintenance accountability, jobs, and inventory control (MAJIC) program: User's manual.** Adkisson, B.P. Oak Ridge National Lab., TN (USA). Jan 1990. 59p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC05-84OR21400. (ORNL/CF–87/263). Order Number DE90006427. Available from NTIS, PC A04/MF A01 - OSTI.

This document describes the operating procedures for the maintenance accountability, jobs, and inventory control (MAJIC) program for the Maintenance Management Department of the ORNL Instrumentation and Controls Division.

21085 (UPS–1988) **Research aspects in the Paris-Sud University, in 1988.** Paris-11 Univ., 91 - Orsay (France). 1988. 75p. (In French). Order Number DE90752561. Available from NTIS (US Sales Only), PC A04/MF A01.

Some of the research works developed in the Paris-Sud University, in 1988, are reported. In this second volume, the following research papers are presented: the antiprogesterone; the English Channel Tunnel; the individual will concerning filiation; the glycannic variations of the alpha 1; the molecular phylogenies; the adrenergetical transmission and the beta receptors; the organical phases and crystallogenesis in the carbonaceous biomineralizations; the quarks electric charge determination; the X-imagery; the regulation of the enzymatic activities by light in the superior vegetals; the chemical reaction dynamical analysis; the experiment report concerning heavy ions - high density plasma interactions; the $^{13}C/^{12}C$ isotopic splitting during photosynthesis; the articular prothesis methodology; and the public authorities and commerce in France.

9902 Mathematics and Computers

Refer also to citation(s) 19174, 19208, 19214, 19216, 19249, 19276, 19330, 19340, 19365, 19368, 19370, 19373, 19384, 19391, 19407, 19415, 19416, 19469, 19476, 19483, 19501, 19525, 19526, 19531, 19552, 19560, 19562, 19567, 19573, 19574, 19576, 19580, 19581, 19583, 19586, 19612, 19728, 19750, 19777, 19778, 19781, 19785, 19787, 19788, 19833, 19855, 19930, 19936, 19939, 20049, 20050, 20065, 20066, 20081, 20082, 20085, 20087, 20094, 20102, 20129, 20137, 20158, 20159, 20160, 20162, 20163, 20164, 20165, 20166, 20167, 20168, 20169, 20170, 20176, 20187, 20189, 20217, 20218, 20223, 20224, 20229, 20232, 20236, 20238, 20250, 20251, 20252, 20253, 20285, 20344, 20370, 20407, 20464, 20473, 20659, 20724, 20783, 20814, 20839, 20840, 20915, 20954, 20959, 21116

21086 (AD-A–214035/8/XAB) **VLSI (Very Large Scale Integration) theory and parallel supercomputing. Technical report.** Leiserson, C.E. Massachusetts Inst. of Tech., Cambridge, MA (USA). Lab. for Computer Science. May 1989. 18p. (MIT/LCS/TM–402). Available from NTIS, PC A03/MF A01.

Supersedes report dated Mar 89, AD-A208 290.

Since its inception, VLSI theory has expanded in many fruitful and interesting directions. One major branch is layout theory, which studies the efficiency with which graphs can be embedded in the plane according to VLSI design rules. This survey paper, reviews some of the major accomplishments of VLSI layout theory and discuss how layout theory engendered the notion of area and volume-universal networks, such as fat-trees. These scalable networks offer a flexible alternative to the more-common hypercube-based networks for interconnecting the processors of large parallel supercomputers.

21087 (AD-A–214112/5/XAB) **Efficient exploitation of speculation under data-flow paradigms of control. Technical report.** Soley, R.M. Massachusetts Inst. of Tech., Cambridge, MA (USA). Lab. for Computer Science. Nov 1989. 165p. (MIT/LCS/TR–443). Available from NTIS, PC A08/MF A01.

Data-flow architectures to exploit the parallelism in large scientific codes are now taking form. However, no approach to exploiting speculative, searching parallelism has been explored, even though (or perhaps because) the potential parallelism of such applications is tremendous. A view of speculation as a process which may proceed in parallel in a controlled fashion is explored, using examples from actual symbolic processing situations. The central issue of exploiting this parallelism is the dynamic containment of the resources necessary to execute large speculative codes. We show efficient structures (graph schemata and architectural support) for executing highly speculative programs (such as expert systems) under a data-flow-executing paradigm. Controls over cross-procedure parallelism in an extensible manner will be presented, with applications to the various current problems of data flow computation. Approaches to scheduling, prioritization and search-tree pruning are considered, evaluated and compared.

21088 (AD-A–214325/3/XAB) **Hierarchical Process Composition: Dynamic maintenance of structure in a distributed environment. Doctoral thesis.** Friedberg, S.A. Rochester Univ., NY (USA). Dept. of Computer Science. 1988. 166p. (TR–294). Available from NTIS, PC A08/MF A01.

This dissertation is an in-depth study of a method, called Hierarchial Process Composition (HPC), for organizing, developing, and maintaining large distributed programs. HPC extends the process abstraction to nested collections of processes, allowing a multiprocess program in place of any single process, and provides a rich set of structuring mechanisms for building distributed applications. The emphasis in HPC is on structural and architectural issues in distributed software systems, especially interactions involving dynamic reconfiguration, protection, and distribution. The major contributions of this work come from the detailed consideration, based on case studies, formal analysis, and a prototype implementation, of how abstraction and composition interact in unexpected ways with each other and with a distributed environment. HPC ties processes together with heterogeneous interprocess communication mechanisms, such as TCP/IP and remote-procedure call. Explicit structure determines the logical connectivity between processes, masking differences in communication mechanisms. HPC supports one-to-one, parallel channel, and many-to-many (multicasting) connectivity. Efficient computation of end-to-end connectivity from the communication structure is a challenging problem, and a third-party connection facility is needed to implement dynamic reconfiguration when the logical connectivity changes.

21089 (AD-A–214447/5/XAB) **Algorithms for fault-tolerant distributed systems. Final technical report, February 1985-February 1988.** Lamport, L.; Melliar-Smith, P.M.; Moser, L.; Greenberg, I.; Rushby, J. SRI International, Menlo Park, CA (USA). Computer Science Lab. Oct 1989. 214p. Available from NTIS, PC A10/MF A02.

The research described is presented in six parts: (1) Interprocess Communication studies interprocess communication without assuming any lower-level communication primitives. A formalism is developed for reasoning about concurrent systems that does not assume an atomic grain of action; (2) The Intersecting Broadcast Machine is a novel array processor architecture, capable of processing efficiently programs whose arbitrary or complex structure would make them difficult to map onto conventional array processors. The architecture also supports fault-tolerant operation: (3) Broadcast Protocols for Distributed Systems considers how the broadcast character of communications media such as Ethernet and packet radio can be exploited to yield reliable communication with very little overhead; (4) Extending Interval Logic to Real Time Systems presents a technique for the formal expression of the real-time constraints that are critical to the specification of fault-tolerant distributed systems; (5) Consistency of Replicated Information in Multichannel Fault Tolerant Systems considers the possibility of using similar, but not identical, processing in the replicas of a fault-tolerant system. Conventional fault-tolerant systems using replicate processing require the replicas to be identical, so that they can be compared by exact match algorithms. This exact replication increases the risk that a common fault will affect all replicas and cause system failure; and (6) Experimental Implementation and Evaluation of the TRANS Broadcast Protocol describes an implementation and evaluation of the broadcast protocol outlined in Part III.

21090 (ANL–87-26-Vol.2, pp. 79-103) **Asymptotics of the Titchmarsh-Weyl m-coefficient for nonintegrable potentials.** Atkinson, F.V. (Univ. of Toronto, Ontario (Canada)); Fulton, C.T. Argonne National Lab., IL (USA). Sep 1988. In *Proceedings of the focused research program on spectral theory and boundary value problems. Volume 2: Singular differential equations.* Order Number DE89006399. Available from NTIS, PC A05/MF A01.

Asymptotic formulae for the Tichmarsh-Weyl m-coefficient on rays in the complex λ-plane for the equation $-y + qy = \lambda y$ when the potential is limit circle and nonoscillatory at $x = 0$ are obtained under assumptions slightly more general than $xq(x) \in L_1(0,c)$. The behavior of q at the right endpoint is arbitrary and may fall in either the limit point or limit circle case. A method of regularization of the equation is given that can be made to depend either on a solution of the equation for $\lambda = 0$ or more directly on an approximation to the solution in terms of q. This enables equivalent definitions of the m-coefficient to be given for the singular Sturm-Liouville problem associated with a singular limit circle boundary condition, and its associated regular Sturm-Liouville problem. As a consequence, it becomes possible to apply asymptotic results obtained by Atkinson for the regular problem in order to give asymptotic results for the singular problem. Potentials of the form $q(x) = C/x^j$, $1 \leq j \leq 2$, are included. In the case $j = 1$ an independent calculation of the limit point m-coefficient over the range $(0,\infty)$ relying on Whittaker functions verifies the main result. 29 refs.

21091 (ANL/MCS-TM–136) **Summer institute in parallel computing, September 5–15, 1989.** Dongarra, J.; Lusk, E. Argonne National Lab., IL (USA). Mathematics and Computer Science Div. Dec 1989. 7p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract W-31109-ENG-38. (CONF-8909296–Summ.: Summer institute in parallel computing, Argonne, IL (USA), 5-15 Sep 1989). Order Number DE90005532. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This report discusses the following on the summer institute in parallel computing: introduction; background of the summer institute; objective; the attendees; the invited speakers; the Argonne

speakers; the schedule; evaluation by the attendees; evaluation by the organizers; and summary.

21092 (ANL/TM–458-Rev.2) **ANL statement of site strategy for computing workstations: Revision 2.** Opitz, L.C. (ed.); Boxberger, L.M.; Izzo, R. Argonne National Lab., IL (USA). Sep 1989. 58p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. Order Number DE90008097. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This Statement of Site Strategy describes the procedure at Argonne National Laboratory for defining, acquiring, using, and evaluating microcomputer and word processing equipment and software in accord with DOE Order 1360.1A (5-30-86), and Laboratory policy. It is Laboratory policy to promote the installation and use of computing workstations to improve productivity and communications for both programmatic and support personnel, to ensure that computing workstation acquisitions meet the expressed need in a cost-effective manner, and to ensure that acquisitions of computing workstations are in accord with Laboratory and DOE policies.

21093 (CEA-CONF–9858) **Computation of 3D form factors in complex environments.** Coulon, N. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. d'Etudes Mecaniques et Thermiques. 1989. 5p. (CONF-890408–: Topical meeting on advances in nuclear engineering computation and radiation shielding, Santa Fe, NM (USA), 9-13 Apr 1989). Order Number DE90752524. Available from NTIS (US Sales Only), PC A02/MF A01.

The calculation of radiant interchange among opaque surfaces in a complex environment poses the general problem of determining the visible and hidden parts of the environment. In many thermal engineering applications, surfaces are separated by radiatively non-participating media and may be idealized as diffuse emitters and reflectors. Consenquently the net radiant energy fluxes are intimately related to purely geometrical quantities called form factors, that take into account hidden parts: the problem is reduced to the form factor evaluation. This paper presents the method developed for the computation of 3D form factors in the finite-element module of the system TRIO, which is a general computer code for thermal and fluid flow analysis. The method is derived from an algorithm devised for synthetic image generation. A comparison is performed with the standard contour integration method also implemented and suited to convex geometries. Several illustrative examples of finite-element thermal calculations in radiating enclosures are given.

21094 (CEA-CONF–9860) **Seismic analysis of a structure sliding on its support.** Brochard, D.; Gantenbein, F. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. d'Etudes Mecaniques et Thermiques. 1989. 10p. (In French). (CONF-8904262–: 2. national symposium on paraseismic engineering, Saint-Remy-les-Chevreuse (France), 18-20 Apr 1989). Order Number DE90752522. Available from NTIS (US Sales Only), PC A02/MF A01.

The aim of this paper is to present the behavior of a structure sliding on its support excited by a seism. The structure is represented by a 2 degrees of freedom simplified model. Calculations have been performed using a nonlinear method based on modal synthesis. Results have shown the influence of the sliding on the response of the structure and in the same way the influence of the structure characteristics (stiffness and mass).

21095 (CEA-CONF–9861) **A finite element method for a time dependence soil-structure interactions calculations.** Ni, X.M.; Gantenbein, F.; Petit, M. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. d'Etudes Mecaniques et Thermiques. 1989. 10p. (In French). (CONF-8904262–: 2. national symposium on paraseismic engineering, Saint-Remy-les-Chevreuse (France), 18-20 Apr 1989). Order Number DE90752521. Available from NTIS (US Sales Only), PC A02/MF A01.

The method which is proposed is based on a finite element modelisation for the soil and the structure and a time history calculation. It has been developed for plane and axisymmetric geometries. The principle of this method will be presented, then applications will be given, first to a linear calculation for which results will be compared to those obtained by standard methods. Then results for a non linear behavior will be described.

21096 (CONF-900343–5) **The advanced controls program at Oak Ridge National Laboratory.** Knee, H.E.; White, J.D. Oak Ridge National Lab., TN (USA). 1990. 6p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. From Supercomputing in nuclear applications; Mito City (Japan); 12-16 Mar 1990. Order Number DE90007478. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The Oak Ridge National Laboratory (ORNL), under sponsorship of the US Department of Energy (DOE), is conducting research that will lead to advanced, automated control of new liquid-metal-reactor (LMR) nuclear power plants. Although this program of research (entitled the "Advanced Controls Program") is focused on LMR technology, it will be capable of providing control design, test, and qualification capability for other advanced reactor designs (e.g., the advanced light water reactor [ALWR] and high temperature gas-cooled reactor [HTGR] designs), while also benefiting existing nuclear plants. The Program will also have applicability to complex, non-nuclear process control environments (e.g., petrochemical, aerospace, etc.). The Advanced Controls Program will support capabilities throughout the entire plant design life cycle, i.e., from the initial interactive first-principle dynamic model development for the process, systems, components, and instruments through advanced control room qualification. The current program involves five principal areas of research activities: (1) demonstrations of advanced control system designs, (2) development of an advanced controls design environment, (3) development of advanced control strategies, (4) research and development (R&D) in human-system integration for advanced control system designs, and (5) testing and validation of advanced control system designs. Discussion of the research in these five areas forms the basis of this paper. Also included is a description of the research directions of the program. 8 refs.

21097 (CONF-900464–1) **A virtual zero-time, monolithic systolic sorting array.** Britton, C.L. Jr. (Oak Ridge National Lab., TN (USA)); Ericson, M.N.; Bouldin, D.W. Oak Ridge National Lab., TN (USA). [1990]. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From IEEE Southeastcon; New Orleans, LA (USA); 1-4 Apr 1990. Order Number DE90001000. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A virtual zero-time monolithic sorting chip is described. The chip has a systolic array architecture and implements the "sinking sort" algorithm. The basic functional module of the systolic array is detailed and development techniques employed as well as functional simulation and results are presented. Lessons learned and educational significance of the development of this chip at a university are discussed. 3 refs., 4 figs.

21098 (CONF-9004125–1) **An approach to elemental task learning.** Belmans, P. Oak Ridge National Lab., TN (USA). [1990]. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 8. SPIE's applications of artificial intelligence conference; Orlando, FL (USA); 17-19 Apr 1990. Order Number DE90006614. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In this article we deal with the automated learning of tasks by a robotic system through observation of a human operator. Particularly, we explain what is meant by a learning ability in autonomous robots and in teleoperation systems, where several operators and several machines may work in cooperation to perform tasks. We discuss different approaches to learning in these systems and outline the features of the models they are based upon. This leads us to choose an analytical model suited for tasks analysis. We then present the software architecture for our proposed approach and show the first results obtained on sample tests. 5 refs., 9 figs.

21099 (CONF-9004125–2) **Hybrid neural network and rule-based pattern recognition system capable of self-modification.** Glover, C.W. (Oak Ridge National Lab., TN (USA)); Silliman, M.; Walker, M.; Spelt, P.F.; Rao, N.S.V. Oak Ridge National Lab., TN (USA). [1990]. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 8. SPIE's applications of artificial intelligence conference; Orlando, FL (USA); 17-19 Apr 1990. Order Number DE90007482. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper describes a hybrid neural network and rule-based pattern recognition system architecture which is capable of self-modification or learning. The central research issue to be addressed for a multiclassifier hybrid system is whether such a system can perform better than the two classifiers taken by themselves. The hybrid system employs a hierarchical architecture, and it can be interfaced with one or more sensors. Feature extraction routines operating on raw sensor data produce feature vectors which serve as inputs to neural network classifiers at the next level in the hierarchy. These low-level neural networks are trained to provide further discrimination of the sensor data. A set of feature vectors is formed from a concatenation of information from the feature extraction routines and the low-level neural network results. A rule-based classifier system uses this feature set to determine if certain expected environmental states, conditions, or objects are present in the sensors' current data stream. The rule-based system has been given an a priori set of models of the expected environmental states, conditions, or objects which it is expected to identify. The rule-based system forms many candidate directed graphs of various combinations of incoming features vectors, and it uses a suitably chosen metric to measure the similarity between candidate and model directed graphs. The rule-based system must decide if there is a match between one of the candidate graphs and a model graph. If a match is found, then the rule-based system invokes a routine to create and train a new high-level neural network from the appropriate feature vector data to recognize when this model state is present in future sensor data streams. 12 refs., 3 figs.

21100 (DOE/ER/25009–848) **Parallel neural net path-planner on hypercube and transputer.** Ho, A.W.; Fox, G.C. California Inst. of Tech., Pasadena, CA (USA). Concurrent Computation Project. 8 Dec 1989. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract FG03-85ER25009. (CONF-900392–1: International conference on parallel processing in nervous system and computers, Dusseldorf (Germany, F.R.), Mar 1990). Order Number DE90006324. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The task of finding a "good" path is of prime importance to any automated vehicle navigation controller. This task has been formulated as problems in computational geometry, which is commonly reduced to a graph search problem. We report here the preliminary results of a new approach that finds a "good," if not optimal, path dynamically and in real-time by casting the task as a classification problem. The path-planner implements a back-propagation model for classification. The multi-scale representational strategy used for mapping the problem domain onto the input space of the back-propagation model ensures the applicability of the trained network to instances of the problem, which differ in the distribution of obstacles and the size of the problem domain. Software simulations based on the parallel computer EXPRESS operating system run, without modification of code, in Transputer-based systems as well as hypercube concurrent processor, with satisfactory efficiency. 10 refs., 7 figs.

21101 (KFK–4644) **SINSUR interpolates smoothly in a two-dimensional table using splines.** Thurnay, K. Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Schneller Brueter. Nov 1989. 48p. Order Number DE90753508. Available from NTIS (US Sales Only), PC A03/MF A01.

There exist two versions of SINSUR, one - written in FORTRAN77 - to interpolate in a batch-job and one - written in SPEAKEASY - to interpolate in a TSO-session. The paper describes the main features of the procedure, what the user should do in order to get access to the batch-version of SINSUR, and a sample of a SPEAKEASY-session, in which the TSO-version of SINSUR was used. (orig.).

21102 (LA-UR–90-356) **Nonlinear system vibration—The appearance of chaos.** Hunter, N.F. Jr. Los Alamos National Lab., NM (USA). 1990. 8p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-900479–6: 36. Institute of Environmental Science annual technology meeting, New Orleans, LA (USA), 23-27 Apr 1990). Order Number DE90007546. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper begins with an examination of the differential equation for a single degree of freedom force excited oscillator and considers the state space behavior of linear, nonlinear, and chaotic single degree of freedom systems. The fundamental characteristics of classical chaos are reviewed: sensitivity to initial conditions, positive Lyapunov exponents, complex Poincare maps, fractal properties of motion in the state space, and broadening of the power spectrum of the system response. Illustrated examples of chaotic behavior include motion in a two well potential – the chaos beam described in Moon and a hardening base excited Duffing system. Chaos-like phenomenon which occur with nonperiodic forcing are examined in the context of the two well potential and hardening Duffing systems. The paper concludes with some suggestions for detecting and modelling nonlinear or chaotic behavior. 19 refs., 19 figs.

21103 (LA-UR–90-379) **Computation at the edge of chaos: Phase transition and emergent computation.** Langton, C. Los Alamos National Lab., NM (USA). 25 Jan 1990. 75p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-8905201–5: Conference on emergent computation, Los Alamos, NM (USA), 22-26 May 1989). Order Number DE90007488. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

In order for computation to emerge spontaneously and become an important factor in the dynamics of a system, the material substrate must support the primitive functions required for computation: the transmission, storage, and modification of information. Under what conditions might we expect physical systems to support such computational primitives? This paper presents research on Cellular Automata which suggests that the optimal conditions for the support of information transmission, storage, and modification, are achieved in the vicinity of a phase transition. We observe surprising similarities between the behaviors of computations and systems near phase-transitions, finding analogs of computational complexity classes and the Halting problem within the phenomenology of phase-transitions. We conclude that there is a fundamental connection between computation and phase-transitions, and discuss some of the implications for our understanding of nature if such a connection is borne out. 31 refs., 16 figs.

21104 (LA-UR–90-540) **Image manipulation in the SIGGRAPH Interactive Proceedings.** Phillips, R.L. (Los Alamos National Lab., NM (USA)); Beach, R.J. Los Alamos National Lab., NM (USA). [1990]. 8p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-900230–1: SPIE/SPSE symposium and exhibition on electronic imaging: science and technology, Santa Clara, CA (USA), 11-16 Feb 1990). Order Number DE90007542. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We built a multimedia document system for the SIGGRAPH Interactive Proceedings to demonstrate the potentials and challenges in using technology to capture better the essence of SIGGRAPH conferences. The prototype system uses the NeXT computer system to present textual, mathematical, illustrative, colorful, audio, video and animated material. Special attention was given to including tools for interactive manipulation of images included in typical SIGGRAPH papers. 6 refs., 6 figs.

21105 (LA-UR–90-627) **Rule matrices, degree vectors, and preimages for cellular automata.** Jen, E. Los Alamos National Lab., NM (USA). [1989]. 15p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-8906239–3: Santa Fe Institute summer school on complex systems, Santa Fe, NM (USA), 5-30 Jun 1989). Order Number DE90007492. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Cellular automata are mathematical systems characterized by discreteness (in space, time, and state values), determinism, and local interaction. Few analytical techniques exist for such systems. The rule matrix and degree vectors of a cellular automaton – both of which are determined a priori from the function defining the automaton, rather than a posteriori from simulations of its evolution – are introduced here as tools for understanding certain qualitative features of automaton behavior. The rule matrix represents in convenient form the information contained in an automaton's rule

table; the degree vectors are computed from the rule matrix, and reflect the extent to which the system is "one-to-one" versus "many-to-one" on restricted subspaces of the mapping. The rule matrix and degree vectors determine, for example, several aspects of the enumeration and "prediction" of preimages for spatial sequences evolving under the rule, where the preimages of a sequence S are defined to be the set of sequences mapped by the automaton rule onto S. 2 figs., 2 tabs.

21106 (LA-UR–90-714) **Object detection and amplitude estimation based on maximum *a posteriori* reconstructions.** Hanson, K.M. Los Alamos National Lab., NM (USA). [1990]. 22p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-900238–1: SPIE technical conference and exhibition on medical imaging, Newport Beach, CA (USA), 4-9 Feb 1990). Order Number DE90007511. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We report on the behavior of the linear maximum a posteriori (MAP) tomographic reconstruction technique as a function of the assumed rms noise σ_n in the measurements, which specifies the degree of confidence in the measurement data. The unconstrained MAP reconstructions are evaluated on the basis of the performance of two related tasks; object detection and amplitude estimation. It is found that the detectability of medium-sized discs remains constant up to relatively large σ_n before slowly diminishing. However, the amplitudes of the discs estimated from the MAP reconstructions increasingly deviate from their actual values as σ_n increases.

21107 (ORNL/M–828) **Using the K-25 C&TD Common File System: A guide to CFSI [CFS Interface].** Oak Ridge National Lab., TN (USA). Dec 1989. 211p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-84OR21400. Order Number DE90005815. Available from NTIS, PC A10/MF A01 - OSTI; GPO Dep.

A CFS (Common File System) is a large, centralized file management and storage facility based on software developed at Los Alamos National Laboratory. This manual is a guide to use of the CFS available to users of the Cray UNICOS system at Martin Marietta Energy Systems, Inc., in Oak Ridge, Tennessee.

21108 (SAND–88-2958) **Standard Annuciator Software overview.** Anspach, D.A. (Sandia National Labs., Albuquerque, NM (USA)); Fox, E.T.; Kissock, P.S. Sandia National Labs., Albuquerque, NM (USA). Jan 1990. 129p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC04-76DP00789. Order Number DE90006467. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

The Standard Annunciator Software is responsible for maintaining a current display of system status conditions. The software interfaces with other systems – IACS, CCTV, UPS, and portable PC – to determine their status and then displays this information at the operator's console. This manual describes the software organization, operation, and generation mechanisms for development and target environments. 6 figs.

21109 (SAND–89-0077) **A technique for convolving unequally spaced samples using fast Fourier transforms.** Sullivan, T.D. Sandia National Labs., Albuquerque, NM (USA). Jan 1990. 32p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90006466. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A method is presented that allows one to make use of the fast Fourier transform for convolving unequally spaced samples with a system response function. The technique is a shared-power approach and can be described as a type of reverse interpolation. Application to the formation of simulated radar images is also presented. 7 refs., 22 figs., 5 tabs.

21110 (SAND–90-0227C) **Architecture and computing philosophy of the QUICKSILVER, 3D, electromagnetic, particle-in-cell code.** Kiefer, M.L.; Seidel, D.B.; Coats, R.S.; Quintenz, J.P.; Pointon, T.D.; Johnson, W.A. Sandia National Labs., Albuquerque, NM (USA). 1990. 17p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90007070. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Charged-particle simulations in three dimensions are now performed routinely in the Pulsed Power Sciences Directorate at Sandia with the QUICKSILVER suite of codes. QUICKSILVER is a multitasked, finite-difference, three-dimensional, fully relativistic, electromagnetic, particle-in-cell code developed at Sandia. It is targeted for use on current and near-term supercomputers, such as the Cray X-MP/416, which are characterized by large, shared central memories and multiple processors. QUICKSILVER has already been used to simulate ion diodes, magnetically insulated transmission lines, microwave devices, and electron beam propagation. QUICKSILVER is actually a suite of codes; in addition to the main simulation code there are several support codes. The problem geometry is generated with a preprocessor and the simulation results are examined with one or more postprocessors. The MERCURY preprocessor assists the user in defining the mesh, boundary conditions, and other input parameters. The FLASH and AVS postprocessors are used to examine a wide variety of simulation output, including 3D rendering of particle positions, conductor surfaces, and scalar and vector quantities. The PLOTPFF postprocessor displays 2D slices and 1D pencils derived from 3D scalar and vector quantities. Additionally, time histories of various simulation quantities can be examined and manipulated with the IDR postprocessor. This paper describes the suite in detail. 9 refs., 4 figs.

21111 (SLAC-TN–90-2) **Using Rexx to coordinate relational commands.** Rothacker, F. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Feb 1990. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. Order Number DE90007569. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Relational technology has drastically reduced, but not eliminated, the need for a procedural language. The main advantage of relational commands is that they can manipulate entire sets of records in complex ways, without the need to loop through files. What remains is coordinating the execution of relational commands. This paper discusses how Rexx may help to fill that void.

21112 Restoration of piecewise constant images by mean-field annealing. Hiriyannaiah, H.P. (North Carolina State University, Raleigh, North Carolina 27695 (USA)); Bilbro, G.L.; Snyder, W.E.; Mann, R.C. *Journal of the Optical Society of America A: Optics and Image Science (USA),* 6(12): 1901-1912 (Dec 1989).

An algorithm is described that removes the noise from images without causing blurring or other distortions of edges. The problem of noise removal is posed as a restoration of an uncorrupted image, given additive noise. The restoration problem is solved by using a new minimization strategy called mean-field annealing (MFA). An a priori statistical model of the image is chosen that drives the minimization toward solutions that are locally homogeneous. The strategy for mean-field annealing is derived, and the resulting algorithm is discussed. Applications of the algorithm to both synthetic images and real images are presented.

21113 Reconfigurable n-dimensional computer memory. Parks, A.D.; Shuler, A.P. To Department of the Navy, Washington, DC. USA Patent Application 7-408,970. 18 Sep 1989. 20p. Available from NTISPC N03/MF A01.

This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of application available NTIS.

This invention is a computer memory architecture wherein a multiply partitioned N-dimensional memory for serial and parallel computers provides a specialized storage and retrieval media. It can efficiently service associated computational processes with one-dimensional hyperplanes of data that are accessible from any of the N-directions in a single access, or fewer accesses than required of conventional computer memory. This architecture reduces access time and complexity in parallel and array processing.

9903 Information Handling

Refer also to citation(s) 19313, 19330, 19383, 19581, 19625, 20066, 20233, 20344, 20959, 20997, 21111

21114 (CEA-DAS–604) **Application examples of the reports of the NEA Incident Reporting System of the OECD and evolution of the system.** Libmann, J. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. d'Analyse de Surete. Jun 1989. 6p. (In French). (CONF-880511–: International symposium on the feedback of operational safety experience from nuclear power plants, Paris (France), 16-20 May 1988). Order Number DE90752599. Available from NTIS (US Sales Only), PC A02/MF A01.

Some reports of the work group no. 1 of the Nuclear Installations Security Committee of NEA, are summarized. An example of the report coding system concerning human factors, is given. The aim of the study is to improve the report contents as well as the coding system. In this case, a fast data selection is possible, and allows an efficient analysis of a particular situation. Moreover, the corrective procedures of the nuclear installation conception or operation can be easily modified, by the national organisations. Due to the improvements in quality, the opinion of the member countries on the incident reporting systems efficiency was enhanced.

21115 (EGG–10617-1027) **Expanding the functional utility of DOE family libraries through cooperative agreements: Implications for copyright law, fair use, combined purchasing power, and shared resources.** Fisher, W.A. EG and G Idaho, Inc., Idaho Falls, ID (USA). Apr 1989. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC08-88NV10617. (CONF-8906113–3: DOE technical information meeting: INFOTECH, Oak Ridge, TN (USA), 6-7 Jun 1989). Order Number DE90006757. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper will raise broad-based issues which impact on resource management. The maximization of assets and technology have given libraries unique and positive choices to improve research productivity. The economics power of mass purchasing, the accoutrements of technology and approaching copyright law in the spirit as well as the letter of the law, can be a boon for our profession.

21116 (SAND–89-0209/1) **An adaptable modular safeguards control and communications system: Version 2, Overview of the control and display subsystem.** Quintana, G.R. Sandia National Labs., Albuquerque, NM (USA). Jan 1990. 51p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90005824. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The Control and Display Subsystem is the functional heart of the Safeguards Control and Communications System (SCCS). This document provides an overview of the hardware, software, design features, and operating principles of the Control and Display Subsystem for suppliers interested in commercializing this product. The modular design of the SCCS allows for varying components and configurations in its implementation. The functional relationships between the Control and Display Subsystem and other SCCS subsystems are discussed. System enhancements found in this version of the SCCS are also outlined. Complete references are provided to vendors' literature and separate dedicated documents on various components of the subsystem. 7 figs., 10 tabs.

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AC05-84OT21400	**Oak Ridge Gaseous Diffusion Plant, TN (USA)**	
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	Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA)	
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AC05-86OR21548	**Argonne National Lab., IL (USA)**	
	15:19425	DOE/OR/21548–065
	MK-Ferguson Co., St. Charles, MO (USA)	
	15:19426	DOE/OR/21548–109
	15:19752	DOE/OR/21548–082-Rev.2
AC06-76FF02170	**Hanford Engineering Development Lab., Richland, WA (USA)**	
	15:19899	HEDL-SA–3244
AC06-76RL01830	**Hanford Works, Richland, WA (USA)**	
	15:19427	HW–12666-E
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	General Electric Co., Richland, WA (USA). Hanford Atomic Products Operation	
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	ICF Northwest, Richland, WA (USA)	
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AC06-77RL01030	**Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations**	
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	15:19381	RHO-BW-SA–297
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AC06-87RL10930	**Westinghouse Hanford Co., Richland, WA (USA)**	
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	15:19408	WHC-SA–0678
	15:19409	WHC-SA–0694
	15:19410	WHC-SA–0699
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	15:19413	WHC-SA–0738
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	15:19417	WHC-SA–0839
	15:19440	WHC-SA–0631
	15:19450	WHC-SA–0709
	15:19791	WHC-EP–0336
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	15:20084	WHC-SA–0689
	USDOE Richland Operations Office, WA (USA)	
	15:19343	DOE/RL–89-16-Draft-A
AC07-76ID01570	**Geological Survey, Idaho Falls, ID (USA)**	
	15:19424	DOE/ID–22083
	Idaho National Engineering Lab., Idaho Falls, ID (USA)	
	15:19419	DOE/ID–12082-88
	EG and G Idaho, Inc., Idaho Falls, ID (USA)	
	15:19181	EGG-M–89110
	15:19191	EGG-M–88493
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AC07-81NE44139	**West Valley Nuclear Services Co., Inc., West Valley, NY (USA)**	
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AC07-85NV10418	**Ford Motor Co., Dearborn, MI (USA). Research Staff**	
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AC07-86ID12651	**EG and G Idaho, Inc., Idaho Falls, ID (USA)**	
	15:19351	EGG-M–90001
AC07-88ID12698	**Oak Ridge National Lab., TN (USA)**	
	15:20055	CONF-890631–Vol.3
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AC07-88ID12701	**Oak Ridge National Lab., TN (USA)**	
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AC07-88ID12735	**MSE, Inc., Butte, MT (USA)**	
	15:19734	DOE/ID/12735–T5
AC08-87NV10594	**History Associates, Inc., Rockville, MD (USA)**	
	15:20263	DOE/NV/10594–T1
AC08-88NV10617	**EG and G Idaho, Inc., Idaho Falls, ID (USA)**	
	15:21115	EGG–10617-1027
	EG and G Energy Measurements, Inc., Los Alamos, NM (USA). Los Alamos Operations	
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	15:19272	EGG–10617-1039
	Industry Cooperative Hydrogen Fluoride Mitigation/Assessment Program (USA). Water Spray Subcommittee	
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AC09-76SR00001	**Westinghouse Savannah River Co., Aiken, SC (USA)**	
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AC09-76SR00819	Savannah River Ecology Lab., Aiken, SC (USA). Div. of Stress and Wildlife Ecology	
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AC09-89SR18035	Westinghouse Savannah River Co., Aiken, SC (USA)	
	15:19347	DPST-82-389
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	15:19615	WSRC-RP-89-1241
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AC21-82MC24223	Westinghouse Electric Corp., Pittsburgh, PA (USA). Advanced Energy Systems Div.	
	15:19742	DOE/MC/24223-2792
AC21-84MC21203	Institute of Gas Technology, Chicago, IL (USA)	
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AC21-85FC10627	Pennsylvania State Univ., University Park, PA (USA). Coll. of Earth and Mineral Sciences	
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AC21-85MC22009	Columbia Univ., Palisades, NY (USA). Lamont-Doherty Geological Observatory	
	15:19295	DOE/MC/22009-2785
AC21-85MC22062	Massachusetts Univ., Amherst, MA (USA). Dept. of Mechanical Engineering	
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AC21-85MC22064	Science Applications International Corp., Torrance, CA (USA)	
	15:19175	DOE/MC/22064-2796
AC21-86MC21023	Institute of Gas Technology, Chicago, IL (USA)	
	15:19226	CONF-891113-11
AC21-86MC23086	Little (Arthur D.), Inc., Cambridge, MA (USA)	
	15:19176	DOE/MC/23086-2798
AC21-86MC23256	Texas A and M Univ., College Station, TX (USA). Dept. of Mechanical Engineering	
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AC21-86MC23259	West Virginia Univ., Morgantown, WV (USA). Dept. of Physics	
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AC21-88MC24218	Institute of Gas Technology, Chicago, IL (USA)	
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AC22-85BC10846	Texas Univ., Austin, TX (USA). Dept. of Petroleum Engineering	
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AC22-86PC90013	Union Carbide Corp., South Charleston, WV (USA). Solvents and Coatings Materials Div.	
	15:19472	DOE/PC/90013-T11
AC22-86PC90014	UOP, Inc., Des Plaines, IL (USA)	
	15:19473	DOE/PC/90014-T6
AC22-87PC79650	TECOGEN, Inc., Waltham, MA (USA)	
	15:19230	DOE/PC/79650-8
AC22-87PC79670	Babcock and Wilcox Co., Alliance, OH (USA). Research Center	
	15:19735	DOE/PC/79670-5
AC22-88PC88891	Institute of Gas Technology, Chicago, IL (USA)	
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AC22-88PC88951	Institute of Gas Technology, Chicago, IL (USA)	
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AI01-87ER13647	National Bureau of Standards, Gaithersburg, MD (USA)	
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AM03-76SF00010	Stanford Linear Accelerator Center, Menlo Park, CA (USA)	
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AP07-89ID10368	Versar, Inc., Springfield, VA (USA)	
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AS05-79ER10495	Oklahoma Univ., Norman, OK (USA)	
	15:20742	DOE/ER/10495-T1
AS05-80ER10742	Brookhaven National Lab., Upton, NY (USA)	
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AS06-87DP10684	Maryland Univ., College Park, MD (USA). Lab. for Plasma Research	
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AS09-80ER10690	South Carolina Univ., Columbia, SC (USA). Dept. of Physics and Astronomy	
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AT03-76ER70023	Stanford Linear Accelerator Center, Menlo Park, CA (USA)	
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FC03-85DP40200	Rochester Univ., NY (USA). Lab. for Laser Energetics	
	15:20973	DOE/DP/40200-113
FC07-85ID12557	Spectral Sciences, Inc., Burlington, MA (USA)	
	15:20223	DOE/ID/12557-3
FC07-88ID12726	Southwest Research Inst., San Antonio, TX (USA). Instrumentation Research Div.	
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FC07-88ID12795	Manville Sales Corp., Denver, CO (USA). Manville Technical Center	
	15:19798	DOE/ID/12795-1
FC21-86MC11076	Western Research Inst., Laramie, WY (USA)	
	15:19310	DOE/MC/11076-2789
FC22-83FE60149	National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA)	
	15:19261	NIPER-444
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FG01-81ER10984	National Academy of Sciences - National Research Council, Washington, DC (USA)	
	15:19971	DOE/ER/10984-T5
FG01-87CE15325	Energy Concepts Co., Annapolis, MD (USA)	
	15:19509	DOE/CE/15325-T4
FG01-87CE33007	Volunteers in Technical Assistance, Arlington, VA (USA)	
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FG01-88EH79082	Massachusetts Univ., Amherst, MA (USA). Dept. of Public Health	
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FG01-89EH89009	Climate Inst., Washington, DC (USA)	
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FG02-84ER45120	Seton Hall Univ., South Orange, NJ (USA). Dept. of Chemistry	
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FG02-86ER13545	Wayne State Univ., Detroit, MI (USA)	
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FG02-86ER13553	Massachusetts Inst. of Tech., Cambridge, MA (USA)	
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	15:20102	DOE/ER/13553–T3
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FG02-86ER13630	Kansas Univ., Lawrence, KS (USA). Dept. of Chemistry	
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	15:20427	Published article
FG02-87ER40339	Michigan Univ., Ann Arbor, MI (USA)	
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FG02-87ER40342	Colorado School of Mines, Golden, CO (USA)	
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FG02-87ER45315	Michigan Technological Univ., Houghton, MI (USA)	
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FG02-87ER45319	Wisconsin Univ., Madison, WI (USA). Dept. of Physics	
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FG02-88ER13825	Pennsylvania Univ., Philadelphia, PA (USA). Dept. of Chemical Engineering	
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FG02-88ER40452	Brown Univ., Providence, RI (USA). Dept. of Physics	
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FG02-88ER45356	Johns Hopkins Univ., Baltimore, MD (USA)	
	15:19898	DOE/ER/45356–3
FG02-88ER53276	Colorado School of Mines, Golden, CO (USA)	
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FG03-84ER45156	California Univ., San Diego, La Jolla, CA (USA). Dept. of Electrical and Computer Engineering	
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FG03-85ER25009	California Inst. of Tech., Pasadena, CA (USA). Concurrent Computation Project	
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FG03-86ER13548	California Univ., Davis, CA (USA). Dept. of Mechanical Engineering	
	15:20644	DOE/ER/13548–T1
FG03-86ER45230	Brookhaven National Lab., Upton, NY (USA)	
	15:19844	BNL–43762
FG03-86ER52130	California Univ., Los Angeles, CA (USA). Inst. of Plasma and Fusion Research	
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FG03-86ER53239	Science Applications International Corp., San Diego, CA (USA)	
	15:20918	SAIC–87/3044-APPAT-91
FG03-86SF16306	Colorado State Univ., Fort Collins, CO (USA). Solar Energy Applications Lab.	
	15:19511	DOE/SF/16306–T2
FG03-87ER52144	JAYCOR, Torrance, CA (USA). Plasma Technology Div.	
	15:20614	DOE/ER/52144–T1
FG03-89FE61811	East-West Center, Honolulu, HI (USA). Resource Systems Inst.	
	15:19159	CONF-891185–
	East-West Center, Honolulu, HI (USA). Energy Program	
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FG05-80ET53088	Texas Univ., Austin, TX (USA). Inst. for Fusion Studies	
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FG05-84ER45113	Virginia Univ., Charlottesville, VA (USA). Dept. of Physics	
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FG05-85ER13387	Texas Univ., Austin, TX (USA). Dept. of Chemistry	
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FG05-85ER13429	Rice Univ., Houston, TX (USA). Dept. of Chemistry	
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FG05-85ER40226	Vanderbilt Univ., Nashville, TN (USA). Dept. of Physics and Astronomy	
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	15:20690	DOE/ER/40226–5
FG05-86ER40272	Florida Univ., Gainesville, FL (USA). Dept. of Physics	
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FG05-87ER13789	Texas Univ., Austin, TX (USA). Dept. of Chemistry	
	15:20012	DOE/ER/13789–3
FG05-87ER40361	Oak Ridge National Lab., TN (USA)	
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	15:20750	CONF-890826–9
	Tennessee Univ., Knoxville, TN (USA). Dept. of Physics	
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	Tennessee Univ., Knoxville, TN (USA). Dept. of Physics and Astronomy	
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FG05-87ER40376	Vanderbilt Univ., Nashville, TN (USA). Dept. of Physics and Astronomy	
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FG05-87ER45325	Houston Univ., TX (USA)	
	15:19897	DOE/ER/45325–3
FG05-88ER40451	Abilene Christian Univ., TX (USA)	
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FG05-88ER45368	Rutgers–the State Univ., New Brunswick, NJ (USA). Dept. of Ceramics	
	15:19937	DOE/ER/45368–2
FG05-89ER13985	Rutgers–the State Univ., Piscataway, NJ (USA). Serin Physics Lab.	
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FG05-89OR21864	Saint Charles County Water Dept., St. Charles, MO (USA)	
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FG09-84ER40160	Georgia Univ., Athens, GA (USA). Dept. of Physics and Astronomy	
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FG09-87ER45291	Georgia Univ., Athens, GA (USA). Dept. of Physics and Astronomy	
	15:20797	DOE/ER/45291–3
FG21-86MC23139	Pennsylvania Univ., Philadelphia, PA (USA). Dept. of Materials Science and Engineering	
	15:19741	DOE/MC/23139–2794
FG22-85PC80908	Lehigh Univ., Bethlehem, PA (USA). Dept. of Chemistry	
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FG22-86PC90957	University of Southern California, Los Angeles, CA (USA). Dept. of Mechanical Engineering	
	15:19223	DOE/PC/90957–T8
FG22-87PC79909	Stanford Univ., CA (USA). Dept. of Mechanical Engineering	
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FG22-87PC79914	Purdue Univ., Lafayette, IN (USA). School of Chemical Engineering	
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FG22-88PC88913	**University of Southern California, Los Angeles, CA (USA). Dept. of Mechanical Engineering**	
	15:19232	DOE/PC/88913–T3
FG22-88PC88935	**Pennsylvania State Univ., University Park, PA (USA). Coll. of Earth and Mineral Sciences**	
	15:19180	DOE/PC/88935–T4
W-31-109-ENG-38	**Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research**	
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	15:20634	Published article
	15:20701	Published article
	15:20713	Published article
W-31109-ENG-38	**Argonne National Lab., Idaho Falls, ID (USA)**	
	15:19555	CONF-900418–4
	Argonne National Lab., IL (USA)	
	15:19163	ANL/FE–89/6
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	15:20609	ANL–89/39
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	Argonne National Lab., IL (USA). Mathematics and Computer Science Div.	
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	Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering	
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W-7405-ENG-36	**Stanford Linear Accelerator Center, Menlo Park, CA (USA)**	
	15:20186	SLAC-CN–375
	Los Alamos National Lab., NM (USA)	
	15:19363	LA–11695
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	15:19368	LA-UR–90-353
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	15:20130	LA-UR–90-655
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CONF-8805358–		(1988 EPRI heat-rate improvement conference; Richmond, VA (USA); 10-12 May 1988)			
	15:19535	*See* EPRI-GS–6635			
CONF-8806143–		(Nuclear reactor severe accident chemistry symposium; Toronto (Canada); 5-10 Jun 1988)			
11	15:19578	*See* EGG-M–88237			
CONF-8806260–		(19. international symposium on multiparticle dynamics - new data and theoretical trends; Arles (France); 13-17 Jun 1988)			
	15:20696	*See* LAPP-TH–226-88			
CONF-8806445–		(Seminar on non-waste technology; Espoo (Finland); 20-23 Jun 1988)			
Vol.2	15:19821	*See* VTT-SYMP–103			
CONF-8806456–		(Meeting on fields, strings and critical phenomena; Les Houches (France); 28 Jun - 5 aug 1988)			
	15:20715	*See* CEA-CONF–9802			
CONF-880673–		(Hazardous waste management for the oil, gas, and chemicals industries; Chicago, IL (USA); 6-8 Jun 1988)			
1	15:19826	OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616		TI90007596	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-880802–		(22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988)			
12	15:20085	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006313	MF-406
CONF-8809218–		(9. European symposium on antiproton-proton interactions and fundamental symmetries; Mainz (Germany, F.R.); 5-9 Sep 1988)			
4	15:20673	*See* SLAC-PUB–5145			
CONF-8809413–		(3. national conference on the environmental and public health effects of soils contaminated with petroleum products; Amherst, MA (USA); 19-21 Sep 1988)			
Exec.Summ.	15:19284	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006502	MF-602
CONF-8809448–		(Research co-ordination meeting on development of new radiopharmaceuticals; Athens (Greece); 12-15 Sep 1988)			
	15:20041	*See* IAEA-TECDOC–532			
CONF-880969–		(Metal hydrogen systems fundamentals and applications conference; Stuttgart (Germany, F.R.); 4-9 Sep 1988)			
	15:19923				
	15:20819				
	15:20820				
CONF-8810231–		(IAEA technical committee meeting on pellet injection and toroidal confinement; Gut Ising (Germany, F.R.); 24-26 Oct 1988)			
	15:20881	*See* IAEA-TECDOC–534			
CONF-881024–		(TMI-2 accident materials behavior, plant technology and recovery; Washington, DC (USA); 30 Oct - 4 nov 1988)			
21	15:19576	*See* EGG-M–88176			
22	15:19580	*See* EGG-M–88439			
23	15:19575	*See* EGG-M–88172			
24	15:19577	*See* EGG-M–88202			
CONF-8810244–		(16. light water reactor safety conference; Washington, DC (USA); 24-28 Oct 1988)			
4	15:19579	*See* EGG-M–88304			
CONF-8810478–		(Haztech western Canada: hazardous waste management and environmental control conference; Edmonton (Canada); 5-6 Oct 1988)			
	15:19281	*See* HAZ–CE02855			
CONF-881089–		(Electric alternatives to commercial cogeneration; San Diego, CA (USA); 19-21 Oct 1988)			
	15:19761	*See* EPRI-CU–6606			
CONF-881128–		(Eastern oil shale symposium; Lexington, KY (USA); 30 Nov - 2 dec 1988)			
3	15:19307	OSTI; Institute of Gas Technology, 3424 South State St., Chicago, IL 60616		TI90007601	
CONF-8811309–		(Advisory group on the assessment of new developments and trends in radiation chemistry; Bologna (Italy); 14-17 Nov 1988)			
	15:20014	*See* IAEA-TECDOC–527			
CONF-881205–		(Symposium on coal, oil, and gas biotechnology; New Orleans, LA (USA); 5-7 Dec 1988)			
4	15:19471	OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616		TI90007598	
5	15:20432	OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616		TI90007581	
CONF-881218–		(2. North American conference on preparing for climate change; Washington, DC (USA); 6-8 Dec 1988)			
	15:20261	Climate Institute, 316 Pennsylvania Ave., SE, Suite 403, Washington, DC 20003			ND-603
CONF-890103–		(6. symposium on space nuclear power systems; Albuquerque, NM (USA); 9-12 Jan 1989)			
	15:19553	*See* CEA-CONF–9851			
	15:19554	*See* CEA-CONF–9852			
CONF-8901100–		(Solar Energy Research Institute (SERI) anaerobic digestion review meeting; Golden, CO (USA); 25-26 Jan 1989)			
3	15:19464	OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616		TI90007600	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-8901179–		(Chloro-organic substances in the environment; Stockholm (Sweden); 25 Jan 1989)			
Summ.	15:20361	*See* IVL-B–931			
CONF-890126–		(INMM spent fuel management seminar; Washington, DC (USA); 11-13 Jan 1989)			
1	15:19443	*See* K/ITP–238			
CONF-890160–		(4. annual battery conference on applications and advances; Long Beach, CA (USA); 17-19 Jan 1989)			
2	15:19625	*See* EGG-M–89410			
CONF-890173–		(1. international RELAP-5 users seminar; College Station, TX (USA); 31 Jan - 2 feb 1989)			
5	15:19581	*See* EGG-M–89018			
CONF-8902110–		(2. international symposium on the 4th family of quarks and leptons; Santa Monica, CA (USA); 23-25 Feb 1989)			
5	15:20688	NTIS, PC A02/MF A01; OSTI; INIS		DE90007182	MF-414
CONF-8902140–		(High temperature superconducting compounds: processing and related properties; Las Vegas, NV (USA); 27-28 Feb 1989)			
	15:19906	The Metallurgical Society Inc., 420 Commonwealth Dr., Warrendale, PA 15086			
CONF-8902161–		(4. conference on irreversible processes and self-organization; Rostock (German Democratic Republic); 19 Feb 1989)			
	15:20812	*See* KU-HCOE-FL2-R–89-12			
CONF-8902162–		(Aqueous lithium salt blanket workshop; Toronto (Canada); 7-9 Feb 1989)			
1	15:20978	*See* EGG-M–89020			
CONF-890302–		(16. European conference on controlled fusion and plasma physics; Venice (Italy); 13-17 Mar 1989)			
	15:20849	*See* EUR-CEA-FC–1362			
CONF-8903131–		(Chapman conference on the physics of magnetic flux ropes; Hamilton (Bermuda); 27-31 Mar 1989)			
4	15:21006	*See* UCRL–101516			
CONF-8903172–					
	15:20610	*See* CEA-CONF–9838			
	15:20611	*See* CEA-CONF–9848			
	15:20686	*See* CEA-CONF–9839			
	15:20687	*See* CEA-CONF–9840			
CONF-8903175–		(Recontre de Moriond conference; Les Arcs (France); 12-17 Mar 1989)			
3	15:20725	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007334	MF-413
CONF-8903193–		(Workshop on atmospheric trace metals; Oersundsbro (Sweden); 13-15 Mar 1989)			
Summ.	15:20332	*See* SNV–3597			
CONF-8903197–		(Symposium on Asian natural gas - a new era; Singapore (Singapore); 6-9 Mar 1989)			
1	15:19533	OSTI; IGT, 3424 South State Street, Chicago, IL 60616		TI90007577	
CONF-890335–		(13. particle accelerator conference; Chicago, IL (USA); 20-23 Mar 1989)			
	15:20171	*See* CEA-CONF–9836			
274	15:20194	*See* UCRL–100890			
CONF-890374–		(SPIE technical symposium on aerospace sensing; Orlando, FL (USA); 27-31 Mar 1989)			
2	15:20217	*See* LBL–25959			
3	15:20218	*See* LBL–25960			
CONF-890408–		(Topical meeting on advances in nuclear engineering computation and radiation shielding; Santa Fe, NM (USA); 9-13 Apr 1989)			
	15:21093	*See* CEA-CONF–9858			
CONF-890415–		(Computing in high energy physics; Oxford (UK); 10-14 Apr 1989)			
12	15:20659	*See* UFTP-EXP–89-1			
CONF-8904153–		(Symposium on nuclear dynamics and nuclear disassembly; Dallas, TX (USA); 9-14 Apr 1989)			
	15:20740	*See* CEA-CONF–9856			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
	15:20746	*See* CEA-CONF–9857			
CONF-8904164–		(Symposium on ash deposition: mineral matter transformations during combustion; Dallas, TX (USA); 9-14 Apr 1989)			
	15:19187				
CONF-890422–		(International conference on municipal waste combustion; Hollywood, FL (USA); 11-14 Apr 1989)			
4	15:19827	OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616		TI90007597	
CONF-8904242–		(International congress on optical science and engineering; Paris (France); 24-28 Apr 1989)			
	15:20172	*See* CEA-CONF–9843			
CONF-8904262–		(2. national symposium on paraseismic engineering; Saint-Remy-les-Chevreuse (France); 18-20 Apr 1989)			
	15:19930	*See* CEA-CONF–9859			
	15:21094	*See* CEA-CONF–9860			
	15:21095	*See* CEA-CONF–9861			
CONF-8904318–		(I.A.U. colloquium on structure and dynamics of the interstellar medium conference; Granada (Spain); 17-26 Apr 1989)			
1	15:20592	*See* UCRL–101123			
CONF-890491–		(International conference on fifty years of research in nuclear fission; Berlin (Germany, F.R.); 3-7 Apr 1989)			
	15:20759	*See* CEA-CONF–9842			
CONF-8905122–		(13. actinide separations conference; Idaho Falls, ID (USA); May 1989)			
8	15:19322	*See* WHC-SA–0533			
CONF-8905185–		(American Gas Association Operating Section Distribution/Transmission conference; New Orleans, LA (USA); 21-24 May 1989)			
1	15:19302	OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616		TI90007594	
CONF-8905201–		(Conference on emergent computation; Los Alamos, NM (USA); 22-26 May 1989)			
5	15:21103	*See* LA-UR–90-379			
CONF-8905227–		(International conference on radiosurgery a neurosurgical approach to intracranial lesions; Charlottesville, VA (USA); 1-5 May 1989)			
4	15:20462	*See* LBL–28252			
CONF-8905246–		(2. Asian symposium on research reactors (ASRR-II); Serpong (Indonesia); 23-25 May 1989)			
	15:19559	*See* PPA-AL–9			
CONF-890526–		(44. annual Purdue industrial waste conference; West Lafayette, IN (USA); 9-11 May 1989)			
3	15:19194	OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616		TI90007591	
CONF-8905280–		(Haztech Canada Toronto '89: environmental control/hazardous waste management conference; Mississauga (Canada); 16-18 May 1989)			
	15:19808	*See* HAZ–CE02857			
CONF-8905281–		(3. Workshop on nuclear electric power future in the Asia Pacific region; Jakarta (Indonesia); 26 May 1989)			
	15:19710	*See* PPA-AL–10			
CONF-8905282–		(5. Saturne Meeting; Piriac (France); 16-20 May 1989)			
	15:20152	*See* CEA-CONF–9894			
CONF-8905283–		(Symposium on Swift Heavy Ions in Matter (SHIM 89'); Caen (France); 16-19 May 1989)			
	15:20796	*See* CEA-CONF–9847			
CONF-890562–		(14. annual fuel science conference; Palo Alto, CA (USA); 18-19 May 1989)			
1	15:19191	*See* EGG-M–88493			
CONF-890572–		(1. annual fuel cells contractors review meeting; Morgantown, WV (USA); 2-4 May 1989)			
1	15:19740	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007595	MF-114

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-890573–		(15. annual biennial low-rank fuels symposium; St. Paul, MN (USA); 22-25 May 1989)			
	15:19229	*See* DOE/METC–90/6109			
1	15:19164	OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616		TI90007590	
CONF-8906113–		(DOE technical information meeting: INFOTECH; Oak Ridge, TN (USA); 6-7 Jun 1989)			
3	15:21115	*See* EGG–10617-1027			
CONF-8906186–		(Materials Research Society materials analysis workshop; Albuquerque, NM (USA); 14-17 Jun 1989)			
7	15:20729	*See* LA-UR–90-493			
CONF-8906200–		(Large area electron beam diode workshop; Monterey, CA (USA); 7 Jun 1989)			
4	15:20130	*See* LA-UR–90-655			
CONF-8906239–		(Santa Fe Institute summer school on complex systems; Santa Fe, NM (USA); 5-30 Jun 1989)			
3	15:21105	*See* LA-UR–90-627			
CONF-8906256–		(57. military operations research symposium; Fort Leavenworth, KS (USA); 6-8 Jun 1989)			
2	15:20229	*See* K/DSRD–117			
CONF-8906267–		(TASI '89: Theoretical Advanced Summer Institute in elementary particle physics; Boulder, CO (USA); 4-30 Jun 1989)			
5	15:20685	*See* BNL–43793			
CONF-8906282–		(6. interdisciplinary workshop on nonlinear coherent structures in physics, mechanics and biological systems; Montpellier (France); Jun 1989)			
1	15:20838	*See* LA-UR–89-3575			
CONF-8906283–		(2. international workshop of X-ray fluorescence (XRF) and PIXE applications in life sciences; Capri (Italy); 29-30 Jun 1989)			
1	15:20222	*See* BNL–42934			
CONF-8906284–		(6. technical seminar on chemical spills; Calgary (Canada); 5-6 Jun 1989)			
	15:20256	*See* EPS–89-04698			
CONF-8906285–		(Ironworkers convention workshop on the physics of iron; Los Alamos, NM (USA); 14-16 Jun 1989)			
1	15:19872	*See* UCRL–102637			
CONF-8906286–		(Venus geoscience tutorial and Venus geologic mapping workshop; Flagstaff, AZ (USA); 12-15 Jun 1989)			
	15:20532	*See* N–90-12423			
CONF-8906287–		(Max '91 workshop 2: developments in observations and theory for solar cycle 22; Laurel, MD (USA); 8-9 Jun 1989)			
	15:20554	*See* N–90-12459			
CONF-8906288–		(OECD seminar on intrusion; Paris (France); 5-7 Jun 1989)			
	15:19329	*See* CEA-DAS–614			
CONF-890660–		(Institute of Electrical and Electronics Engineers (IEEE) Antennas Propagation Society (AP-S) international symposium; San Jose, CA (USA); 26-30 Jun 1989)			
10	15:20841	*See* UCRL–100232			
CONF-890668–		(Symposium on low-grade fuels; Helsinki (Finland); 12-16 Jun 1989)			
1	15:19165	OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616		TI90007588	
CONF-890673–		(IWGFR specialists meeting on advanced controls for fast reactors; Argonne, IL (USA); 20-22 Jun 1989)			
6	15:19563	*See* IWGFR–71			
CONF-890717–		(European wind energy conference and exhibition; Glasgow (UK); 10-13 Jul 1989)			
3	15:19532	*See* STEV-VIND–89-25			

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CONF-8907183–		(Aspects of electron-molecule scattering and photoionization; New Haven, CT (USA); 22-25 Jul 1989)			
1	15:20622	*See* UCRL–102651			
CONF-890804–		(PHONON '89: 3. international conference on phonon physics and 6th international conference on phonon scattering in condensed matter; Heidelberg (Germany, F.R.); 21-25 Aug 1989)			
1	15:20201	*See* DOE/ER/40452–3			
CONF-8908129–		(12. workshop on nuclear physics; Iguazu Falls (Argentina); 28 Aug - 1 sep 1989)			
5	15:20747	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007338	MF-413
CONF-8908134–		(11. international free electron laser conference; Naples, FL (USA); 28 Aug - 1 sep 1989)			
29	15:21005	*See* UCRL–101154			
30	15:20131	*See* LA-UR–90-696			
CONF-8908148–		(International workshop on relativistic aspects of nuclear physics; Rio de Janeiro (Brazil); 28-31 Aug 1989)			
5	15:20726	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007337	MF-413
CONF-8908155–		(1989 Ecological Society of America symposium on the role of landscape boundaries in the management and restoration of changing environments; Toronto (Canada); 7-10 Aug 1989)			
2	15:20352	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006622	MF-603
CONF-8908209–		(Workshop on the role of plasmas in accelerators; Tsukuba (Japan); 28 Aug - 1 sep 1989)			
1	15:20183	*See* LBL–27965			
CONF-8908210–		(1. international LTE opacity workshop and code comparison study; Abingdon (UK); 30 Aug - 5 sep 1989)			
1	15:20617	*See* LA-UR–90-176			
CONF-890826–		(International nuclear physics conference; Sao Paulo (Brazil); 20-26 Aug 1989)			
9	15:20750	NTIS, PC A02/MF A01; OSTI; INIS		DE90007340	MF-413
CONF-890872–		(Workshop on physics at Fermilab in the 1990's; Breckenridge, CO (USA); 15-24 Aug 1989)			
5	15:20697	*See* LA-UR–90-158			
CONF-890902–		(198. American Chemical Society national meeting; Miami, FL (USA); 10-15 Sep 1989)			
26	15:19166	OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616		TI90007593	
27	15:20741	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007882	MF-413
CONF-890903–		(International Europhysics conference on high-energy physics; Madrid (Spain); 7-14 Sep 1989)			
12	15:20664	*See* FNAL/C–90/14-E			
CONF-8909184–		(IAEA specialists meeting on superconducting materials and magnets; Tokyo (Japan); 4-6 Sep 1989)			
2	15:21007	*See* UCRL–101782			
CONF-8909230–		(44. lecture meeting of Deutsche Gesellschaft fuer Fettwissenschaft e.V.; Trier (Germany, F.R.); 12-15 Sep 1989)			
	15:20335				
CONF-8909231–		(Computer software and applications conference; Orlando, FL (USA); 20-22 Sep 1989)			
	15:20373				
CONF-8909232–		(8. Japan - United States Governmental conference on solid waste management; Honolulu, HI (USA); 6-7 Sep 1989)			
	15:20336				
	15:20337				
	15:20338				
	15:20339				
	15:20340				

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-8909235–		(Technical committee meeting on fundamental aspects of corrosion of zirconium-based alloys in water reactor environments; Portland, OR (USA); 11-15 Sep 1989)			
	15:20341				
	15:20342				
	15:20343				
CONF-8909236–		(JAERI/EPA workshop on residual radiation and recycle criteria; St. Michaels, MD (USA); 27-28 Sep 1989)			
	15:20404				
	15:20405				
	15:20406				
	15:20482				
	15:20483				
CONF-8909247–		(ACS symposium on exotic nuclear spectroscopy; Miami Beach, FL (USA); 11-15 Sep 1989)			
4	15:20748	NTIS, PC A03/MF A01; OSTI; INIS		DE90007058	MF-413
5	15:20761	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007339	MF-413
CONF-8909249–		(Lattice '89 international workshop; Capri (Italy); 18-21 Sep 1989)			
10	15:20684	*See* BNL–43784			
CONF-8909264–		(Conference of the Chemical Coal Upgrading Department on fundamentals and processes of pyrolysis and coking; Essen (Germany, F.R.); 6-8 Sep 1989)			
	15:19981	National Sanitation Foundation, P.O. Box 1468, Ann Arbor, Michigan 48106 $10.00			
CONF-8909295–		(Summer institute in parallel computing; Argonne, IL (USA); 5-15 Sep 1989)			
Summ.	15:21091	*See* ANL/MCS-TM–136			
CONF-8909297–		(11. annual international meeting of the Alternative Natural Philosophy Association; Cambridge (UK); 14-17 Sep 1989)			
1	15:20590	*See* SLAC-PUB–5161			
CONF-8909298–		(NATO conference; Los Alamos, NM (USA); 6-9 Sep 1989)			
1	15:19992	*See* LA-UR–90-196			
CONF-8909299–		(5. French-Japanese symposium on nuclear physics; Dogashima (Japan); 26-30 Sep 1989)			
1	15:20749	*See* BNL–43674			
CONF-8909300–		(International school on nuclear physics, neutron physics and nuclear energy conference; Varna (Bulgaria); 29 Sep - 7 oct 1989)			
1	15:21010	*See* UCRL–102755			
CONF-8909301–		(Grove anniversary (1839-1989) fuel cell symposium; London (UK); 18-21 Sep 1989)			
	15:19743	*See* N–90-11804			
CONF-8909302–		(2. international ion nitriding/carburizing conference; Cincinnati, OH (USA); 18-20 Sep 1989)			
	15:19904	*See* N–90-11902			
CONF-8909303–		(1989 American Flame Research Committee international symposium on combustion in industrial furnaces and boilers; Short Hills, NJ (USA); 25-27 Sep 1989)			
1	15:20101	OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616		TI90007579	
CONF-891007–		(13. IEEE symposium on fusion engineering; Knoxville, TN (USA); 2-6 Oct 1989)			
117	15:20979	*See* EGG-M–89205			
CONF-8910107–		(Electrochemical Society fall meeting; Hollywood, FL (USA); 15-20 Oct 1989)			
	15:19626	*See* N–90-12696			
CONF-8910192–		(2. DOE natural phenomena hazards mitigation conference; Knoxville, TN (USA); 3-5 Oct 1989)			
	15:19572	NTIS, PC A19/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006928	MF-940

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-8910248–		(Annual automotive technology development contractors coordination meeting; Dearborn, MI (USA); 23-26 Oct 1989)			
2	15:19893	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006888	MF-336
5	15:19475	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007053	MF-334
6	15:19894	NTIS, PC A02/MF A01 - OSTI		DE90007050	MF-332
CONF-8910289–		(Western States Section meeting of the Combustion Institute; Livermore, CA (USA); 23-24 Oct 1989)			
5	15:19977	*See* LBL–27911			
CONF-8910304–		(TMS meeting on simulation and theory of evolving microstructures; Indianapolis, IN (USA); Oct 1989)			
2	15:19855	*See* LA-UR–90-459			
3	15:19857	*See* LA-UR–90-660			
CONF-8910320–		(Workshop on primordial nucleosynthesis; Chapel Hill, NC (USA); 6-8 Oct 1989)			
3	15:20734	*See* UCRL–102293			
CONF-8910349–		(INFN Eloisatron Project workshop on high intensity storage rings: status and prospects for superconducting magnets; Erice (Italy); 16-23 Oct 1989)			
1	15:20173	NTIS (US Sales Only), PC A03/MF A01 - OSTI		DE90002570	
CONF-8910350–		(NATO advanced research workshop on dynamics of magnetic fluctuations in high temperature superconductors; Crete (Greece); 10-14 Oct 1989)			
1	15:19895	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006567	MF-406
2	15:19900	*See* LA-UR–90-112			
CONF-8910353–		(14. international conference on infrared and millimeter waves; Wuerzburg (Germany, F.R.); 2 Oct 1989)			
1	15:21009	*See* UCRL–101793			
2	15:21004	*See* UCRL–21231			
CONF-8910354–		(DNA damage and repair in human tissues conference; Upton, NY (USA); 1-4 Oct 1989)			
1	15:20408	*See* BNL–43231-1			
CONF-8910357–		(Impedance and bunch instability workshop; Argonne, IL (USA); 30 Oct - 1 nov 1989)			
1	15:20155	*See* LA-UR–90-315			
CONF-8910358–		(Spacecraft charging technology conference; Monterey, CA (USA); 31 Oct - 3 nov 1989)			
1	15:20249	*See* LA-UR–90-296			
2	15:20212	*See* LA-UR–90-170			
CONF-891044–		(1. international conference on radioactive nuclear beams; Berkeley, CA (USA); 16-18 Oct 1989)			
5	15:20192	*See* TRI-PP–89-92			
6	15:20156	*See* TRI-PP–89-91			
CONF-891055–		(5. international symposium on the production and neutralization of negative ions and beams; Upton, NY (USA); 30 Oct - 3 nov 1989)			
10	15:20182	*See* LBL–27953			
11	15:20184	*See* LBL–28113			
12	15:20193	*See* TRI-PP–89-100			
CONF-891093–		(36. American Vacuum Society national vacuum symposium; Boston, MA (USA); 23-27 Oct 1989)			
25	15:21003	*See* UCLA/PPG–1256			
CONF-891094–		(International conference on accelerator and large experimental physics control systems; Vancouver (Canada); 30 Oct - 3 nov 1989)			
14	15:20187	*See* SLAC-PUB–5035			
15	15:20158	*See* UCRL–101472			
CONF-891097–		(High powered microwave and broadband radio frequency propagation/phenomenology/methodology workshop; Livermore, CA (USA); 23-26 Oct 1989)			
4	15:20786	*See* UCRL–101807			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-891103–		(Winter meeting of the American Nuclear Society; San Francisco, CA (USA); 26-30 Nov 1989)			
66	15:20069	*See* EGG-M–89478			
CONF-891111–		(International gas research conference; Tokyo (Japan); 6-9 Nov 1989)			
2	15:19828	OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616		TI90007231	
3	15:19931	OSTI; Institute of Gas Technologyh, 3424 South State Street, Chicago, IL 60616		TI90007583	
4	15:19195	OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616		TI90007589	
CONF-891113–		(American Institute of Chemical Engineers annual meeting; San Francisco, CA (USA); 5-10 Nov 1989)			
11	15:19226	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007578	MF-113
CONF-8911146–		(Banbury Center conference on mutation induction and heritability in mammalian germ cells; Cold Spring Harbor, NY (USA); 12-15 Nov 1989)			
7	15:20409	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007129	MF-408
8	15:20448	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007125	MF-408
CONF-8911150–		(6. international conference on recent progress in many body theories; Arad (Israel); 6-10 Nov 1989)			
2	15:20646	*See* LA-UR–90-539			
CONF-8911161–		(Particle astrophysics: NASA cosmic ray program for the 1990's and beyond; Greenbelt, MD (USA); 6-8 Nov 1989)			
2	15:20530	*See* LA-UR–90-42			
CONF-8911164–		(1989 superstrings workshop; Tuscaloosa, AL (USA); 8-11 Nov 1989)			
1	15:20720	*See* LA-UR–90-3			
CONF-8911165–		(International seminar on intermediate energy physics (INES-89); Moscow (USSR); 27-30 Nov 1989)			
2	15:20665	*See* LA-UR–90-134			
CONF-8911166–		(Total exposure assessment methodology Environmental Protection Agency symposium; Las Vegas, NV (USA); 27-30 Nov 1989)			
1	15:20334	*See* UCRL–101503			
CONF-8911169–		(3. research co-ordination meeting on measurements and analysis of double differential neutron spectra in (p,n) and (alpha,n) reactions; Bologna (Italy); 13-15 Nov 1989)			
	15:20728	*See* INDC(NDS)–230/L			
CONF-891117–		(34. conference on magnetism and magnetic materials; Boston, MA (USA); 28 Nov - 1 dec 1989)			
14	15:19844	*See* BNL–43762			
CONF-891119–		(Materials Research Society fall meeting; Boston, MA (USA); 27 Nov - 2 dec 1989)			
100	15:19932	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007574	MF-114
101	15:19889	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007885	
94	15:19941	*See* LBL–28193			
95	15:19940	*See* LBL–28096			
96	15:20142	*See* UCRL–102757			
97	15:19948	*See* SAND–89-1712C			
98	15:19867	*See* SAND–90-0152C			
99	15:19888	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007573	
CONF-891130–		(3. international conference on processing and utilization of high-sulphur coals; Ames, IA (USA); 14-18 Nov 1989)			
4	15:19181	*See* EGG-M–89110			
CONF-891167–		(Eastern oil shale symposium; Lexington, KY (USA); 15-17 Nov 1989)			
2	15:19308	OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616		TI90007582	
3	15:19309	OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616		TI90007580	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-891185–		(Asia-Pacific coal technology conference; Honolulu, HI (USA); 14-16 Nov 1989)			
	15:19159	NTIS, PC A19/MF A01 - OSTI		DE90006339	PC-101
CONF-891202–		(4. thermal performance of the exterior envelopes of buildings; Orlando, FL (USA); 4-7 Dec 1989)			
10	15:19750	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007127	MF-350
CONF-891204–		(4. international conference on fusion reactor materials; Kyoto (Japan); 4-8 Dec 1989)			
20	15:20994	*See* LA-UR–90-452			
CONF-891205–		(IEEE international electron devices meeting; Washington, DC (USA); 3-6 Dec 1989)			
3	15:21008	*See* UCRL–101784			
CONF-891208–		(Winter annual meeting of the American Society of Mechanical Engineers; San Francisco, CA (USA); 10-15 Dec 1989)			
29	15:19859	*See* LBL–27775			
CONF-891240–		(First international Toki conference on plasma physics and controlled nuclear fusion; Toki (Japan); 4-8 Dec 1989)			
6	15:20969	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006620	MF-420
CONF-891251–		(International conference on lasers '89; New Orleans, LA (USA); 3-8 Dec 1989)			
8	15:20995	*See* LA-UR–90-599			
CONF-891269–		(1989 winter school on quark-gluon plasma; Puri (India); 5-16 Dec 1989)			
2	15:20660	*See* BNL–43818			
CONF-891274–		(Conference on high T_c superconductivity; Los Alamos, NM (USA); 6-9 Dec 1989)			
2	15:20825	*See* BNL–43733			
CONF-891275–		(1989 Winter simulation conference; Washington, DC (USA); 4-6 Dec 1989)			
1	15:20228	*See* K/DSRD–114			
CONF-891276–		(Workshop on high energy astrophysics in the 21st century; Taos, NM (USA); 10-14 Dec 1989)			
1	15:20594	*See* UCRL–102762			
2	15:20595	*See* UCRL–102763			
3	15:20593	*See* UCRL–102659			
4	15:19783	*See* LA-UR–90-443			
CONF-900109–		(7. symposium on space nuclear power systems; Albuquerque, NM (USA); 7-11 Jan 1990)			
21	15:19454	*See* MLM–3624-OP			
23	15:19738	*See* MLM–3625-OP			
CONF-900132–		(Workshop on decontamination and decommissioning of nuclear facilities; Las Vegas, NV (USA); 22-25 Jan 1990)			
2	15:19441	*See* WSRC-RP–89-1080			
CONF-900133–		(International conference on superconductivity; Bangalore (India); 10-14 Jan 1990)			
1	15:19901	*See* LBL–28305			
CONF-900140–		(SPIE optics, electro-optics and laser applications in science and engineering conference and exhibition; Los Angeles, CA (USA); 20-25 Jan 1990)			
6	15:20253	*See* UCRL–102674			
7	15:20252	*See* UCRL–102653			
8	15:20141	*See* UCRL–101720			
9	15:20623	*See* UCRL–102673			
10	15:19939	*See* LA-UR–90-165			
11	15:20140	*See* UCRL–101650			
CONF-900143–		(Institute for Electronic and Electrical Engineers (IEEE) nuclear science symposium; San Francisco, CA (USA); 22-26 Jan 1990)			
24	15:20188	*See* SLAC-PUB–5112			
25	15:20190	*See* SLAC-PUB–5135			
26	15:20189	*See* SLAC-PUB–5119			
27	15:20209	*See* SLAC-PUB–5123			
28	15:20204	*See* LBL–28141			

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CONF-900160–		(14. annual conference on composites and advanced ceramics; Cocoa Beach, FL (USA); 14-17 Jan 1990)			
3	15:19890	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007126	MF-332
CONF-900161–		(7. Institute of Nuclear Materials Management spent fuel management seminar; Washington, DC (USA); 17-19 Jan 1990)			
4	15:19351	*See* EGG-M–90001			
CONF-900162–		(Technical symposium on laser spectroscopy; Los Angeles, CA (USA); 14-19 Jan 1990)			
2	15:20128	*See* LA-UR–90-161			
CONF-900163–		(Accelerator computer code meeting; Los Alamos, NM (USA); 22-25 Jan 1990)			
2	15:20191	*See* SLAC-PUB–5183			
3	15:20181	*See* LA-UR–90-383			
4	15:20159	*See* UCRL–102731			
5	15:20160	*See* UCRL–102738			
CONF-900171–		(1. international symposium on microbiology of the deep subsurface; Orlando, FL (USA); 15-18 Jan 1990)			
1	15:20349	*See* BNL–43145			
CONF-900210–		(16. annual waste management symposium: working towards a cleaner environment; Tucson, AZ (USA); 25 Feb - 1 mar 1990)			
5	15:19352	*See* EGG-M–90020			
6	15:19417	*See* WHC-SA–0839			
7	15:19440	*See* WHC-SA–0631			
8	15:19409	*See* WHC-SA–0694			
9	15:19413	*See* WHC-SA–0738			
10	15:19350	*See* EGG-M–89333			
11	15:19330	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007124	MF-511
12	15:19331	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007106	MF-721
13	15:19421	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007176	MF-511
14	15:19410	*See* WHC-SA–0699			
15	15:19412	*See* WHC-SA–0705			
16	15:20084	*See* WHC-SA–0689			
17	15:19450	*See* WHC-SA–0709			
18	15:19408	*See* WHC-SA–0678			
19	15:19414	*See* WHC-SA–0796			
20	15:19416	*See* WHC-SA–0829			
21	15:19411	*See* WHC-SA–0700			
22	15:19395	*See* SAND–90-7010C			
CONF-900230–		(SPIE/SPSE symposium and exhibition on electronic imaging: science and technology; Santa Clara, CA (USA); 11-16 Feb 1990)			
1	15:21104	*See* LA-UR–90-540			
CONF-900238–		(SPIE technical conference and exhibition on medical imaging; Newport Beach, CA (USA); 4-9 Feb 1990)			
1	15:21106	*See* LA-UR–90-714			
CONF-900268–		(3. Minerals, Metals and Materials Society world symposium on lead-zinc (Pb-Zn) and related metals; Anaheim, CA (USA); 18-21 Feb 1990)			
1	15:19933	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007130	MF-401
CONF-900278–		(6. international conference on thermal insulation; San Francisco, CA (USA); 12-14 Feb 1990)			
2	15:19934	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007054	MF-350
CONF-900279–		(DOE health and safety conference; Washington, DC (USA); 28 Feb 1990)			
1	15:19332	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007057	MF-400
CONF-900280–		(International workshop on magnetic pulse compression; Lake Tahoe, NV (USA); 12-14 Feb 1990)			
1	15:20138	*See* SAND–90-0277C			
CONF-900282–		(Annual Society of Acoustical Engineers congress; Detroit, MI (USA); 28 Feb 1990)			
1	15:19837	*See* EGG-M–89475			
CONF-900343–		(Supercomputing in nuclear applications; Mito City (Japan); 12-16 Mar 1990)			
2	15:20783	*See* SLAC-PUB–5170			

CONF-900343–

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3	15:20784	*See* SLAC-PUB–5193			
4	15:20915	*See* LA-UR–90-608			
5	15:21096	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007478	MF-506
CONF-900351–		(3. annual presentation: HazMat Central; Rosemont, IL (USA); 13-15 Mar 1990)			
1	15:19793	OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616		TI90007585	
2	15:19794	OSTI; Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616		TI90007587	
CONF-900368–		(International conference on optical science and engineering; Hague (Netherlands); 12-16 Mar 1990)			
1	15:20129	*See* LA-UR–90-496			
2	15:20127	*See* LA-UR–89-669			
CONF-900371–		(1990 capacitor and resistor technology symposium; San Francisco, CA (USA); 26-29 Mar 1990)			
2	15:19950	*See* SAND–89-3135C			
CONF-900391–		(1990 American Institute of Chemical Engineers (AIChE) spring meeting; Orlando, FL (USA); 18-22 Mar 1990)			
1	15:19183	*See* SAND–89-2023C			
3	15:19185	*See* SAND–90-7028C			
4	15:19167	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007584	MF-109
CONF-900392–		(International conference on parallel processing in nervous system and computers; Dusseldorf (Germany, F.R.); Mar 1990)			
1	15:21100	*See* DOE/ER/25009–848			
CONF-900393–		(International forum on fine ceramics '90; Nagoya (Japan); 12-16 Mar 1990)			
1	15:19891	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006613	MF-404
CONF-900394–		(1990 national symposium of the Society of Mexican-American Engineers and Scientists (MAES); Albuquerque, NM (USA); 28-31 Mar 1990)			
1	15:20234	*See* LA-UR–90-255			
2	15:19505	*See* SAND–89-2870C			
CONF-900402–		(199. national meeting of the American Chemical Society; Boston, MA (USA); 22-27 Apr 1990)			
1	15:19949	*See* SAND–89-2512C			
2	15:20350	*See* BNL–43551			
3	15:19188	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005278	MF-401
4	15:19987	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005663	MF-401
CONF-900403–		(Corrosion '90; Las Vegas, NV (USA); 23-27 Apr 1990)			
1	15:20970	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90002708	MF-423
2	15:19846	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90003689	MF-114
3	15:19333	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90003827	MF-804
4	15:19887	*See* BNL–43358			
5	15:19168	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005639	MF-114
6	15:20050	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005630	MF-310; MF-114
7	15:19546	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005631	
CONF-900406–		(International conference for high-level radioactive waste management; Las Vegas, NV (USA); 8-12 Apr 1990)			
1	15:19385	*See* SAND–89-2026C			
2	15:20078	*See* SAND–89-2052C			
3	15:19390	*See* SAND–89-2349C			
4	15:19935	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90002261	MF-814
5	15:19384	*See* SAND–89-2018C			
7	15:19444	*See* LA-UR–89-4151			
8	15:19386	*See* SAND–89-2050C			
9	15:20370	*See* SAND–89-1988C			
10	15:19389	*See* SAND–89-2099C			
11	15:19334	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90005455	MF-810
12	15:20063	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90005447	MF-820
14	15:19392	*See* SAND–89-3069C			
15	15:19388	*See* SAND–89-2098C			
16	15:19387	*See* SAND–89-2073C			
17	15:19383	*See* SAND–88-2845C			

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18	15:20079	*See* SAND–89-2250C			
19	15:19391	*See* SAND–89-3047C			
20	15:19325	*See* SAND–89-3046C			
21	15:19393	*See* SAND–89-7019C			
22	15:19415	*See* WHC-SA–0808			
23	15:19326	*See* WHC-SA–0749			
24	15:19366	*See* LA-UR–90-183			
25	15:19365	*See* LA-UR–90-68			
26	15:19364	*See* LA-UR–90-13			
27	15:19367	*See* LA-UR–90-351			
28	15:19368	*See* LA-UR–90-353			
29	15:19328	*See* BNL–43768			
30	15:20080	*See* SAND–89-2263C			
31	15:20064	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007051	MF-810
32	15:19324	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007055	MF-820
33	15:19335	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006145	MF-800
CONF-9004115–		(2. Beijing seminar on arms control; Beijing (China); 3-10 Apr 1990)			
1	15:19840	*See* UCRL–102585			
CONF-9004116–		(AIAA/ASME SDM conference; Long Beach, CA (USA); 2-4 Apr 1990)			
1	15:20251	*See* SAND–90-0092C			
2	15:20224	*See* SAND–89-1980C			
CONF-9004125–		(8. SPIE's applications of artificial intelligence conference; Orlando, FL (USA); 17-19 Apr 1990)			
1	15:21098	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006614	MF-406
2	15:21099	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007482	MF-405
CONF-9004134–		(Field monitoring for a purpose conference; Gothenburg (Sweden); 2-5 Apr 1990)			
1	15:19751	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007128	MF-350
CONF-9004135–		(ESD expert system conference; Detroit, MI (USA); 3-5 Apr 1990)			
1	15:20066	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007113	MF-706
CONF-9004136–		(5. IEEE symposium on electromagnetic launch technology; Destin, FL (USA); 1-5 Apr 1990)			
2	15:20250	*See* LA-UR–90-456			
3	15:20814	*See* LA-UR–90-668			
CONF-900414–		(Advances in material science and applications of high temperature superconductors; Greenbelt, MD (USA); 2-6 Apr 1990)			
1	15:19892	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006894	MF-404
CONF-900418–		(International conference on the physics of reactors: operation, design and computation; Marseilles (France); 23-26 Apr 1990)			
1	15:20971	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016859	MF-426
2	15:20768	*See* LA-UR–89-3386			
3	15:19552	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90003824	MF-538
4	15:19555	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005634	MF-528
5	15:20760	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006153	MF-413
CONF-900419–		(8. international triennial conference on thin films and the 17th international conference on metallurgical coatings; San Diego, CA (USA); 1-6 Apr 1990)			
1	15:19856	*See* LA-UR–90-654			
CONF-900425–		(4. international conference on creep and fracture of engineering materials and structures; Swansea (UK); 1-6 Apr 1990)			
1	15:19854	*See* LA-UR–90-25			
2	15:19852	*See* LA-UR–90-23			
3	15:19853	*See* LA-UR–90-24			
4	15:19871	*See* UCRL–102284			
CONF-900442–		(Engineering, construction and operations for space; Albuquerque, NM (USA); Apr 1990)			
1	15:20077	*See* SAND–89-0753C			
2	15:20492	*See* LA-UR–89-3013			
3	15:19782	*See* LA-UR–89-3858			
CONF-900449–		(ASME international solar energy conference; Miami, FL (USA); 1-4 Apr 1990)			
1	15:19502	*See* SAND–89-1582C			
2	15:19514	*See* SAND–89-1500C			

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3	15:19503	*See* SAND–89-2360C			
4	15:19504	*See* SAND–89-2772C			
5	15:19480	*See* SAND–89-1506C			
6	15:19482	*See* SAND–89-1811C			
7	15:19513	*See* SERI/TP–253-3614			
8	15:19507	*See* SERI/TP–254-3619			
9	15:19515	*See* SAND–89-2955C			
CONF-900450–		(Nuclear structure in the '90's; Oak Ridge, TN (USA); 23-27 Apr 1990)			
1	15:20769	*See* LA-UR–90-1			
CONF-900464–		(IEEE Southeastcon; New Orleans, LA (USA); 1-4 Apr 1990)			
1	15:21097	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90001000	MF-405
2	15:19776	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005449	
3	15:19561	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006144	MF-523
4	15:20065	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006618	
CONF-900466–		(Spring meeting of the Materials Research Society; San Francisco, CA (USA); 16-21 Apr 1990)			
1	15:20136	*See* SAND–89-2959C			
CONF-900479–		(36. Institute of Environmental Science annual technology meeting; New Orleans, LA (USA); 23-27 Apr 1990)			
1	15:20099	*See* SAND–89-2867C			
2	15:20082	*See* SAND–90-0335C			
3	15:19789	*See* SAND–89-1658C			
4	15:19790	*See* SAND–89-2140C			
5	15:20081	*See* SAND–90-0334C			
6	15:21102	*See* LA-UR–90-356			
CONF-900480–		(Symposium on frontiers of polymer characterization by NMR spectroscopy; Boston, MA (USA); 22-27 Apr 1990)			
1	15:19954	*See* UCRL–101922			
CONF-900483–		(1990 American Society of Civil Engineers Water Resources Planning and Management Division specialty conference; Fort Worth, TX (USA); 17-20 Apr 1990)			
1	15:20262	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90003674	MF-402
CONF-900494–		(1990 SCS Eastern multiconference; Nashville, TN (USA); 23-29 Apr 1990)			
2	15:19560	*See* BNL–43705			
CONF-900497–		(Structure of surfaces and interfaces as studied by synchrotron radiation: Foraday disc. 89; Manchester, NH (USA); 4-6 Apr 1990)			
1	15:19843	*See* BNL–43662			
CONTRIB–					
472	15:20474	*See* PB–90-129271/XAB			
CRDEC-TR–					
071	15:20468	*See* AD-A–214201/6/XAB			
110	15:20254	*See* AD-A–214200/8/XAB			
CRIE-W–					
88002	15:19169	NTIS (US Sales Only), PC A03/MF A01		DE90753076	
88008	15:19170	NTIS (US Sales Only), PC A03/MF A01		DE90753077	
88010	15:19227	NTIS (US Sales Only), PC A03/MF A01		DE90753078	
88013	15:19171	NTIS (US Sales Only), PC A03/MF A01		DE90753079	
88015	15:19221	NTIS (US Sales Only), PC A03/MF A01		DE90753080	
88016	15:19172	NTIS (US Sales Only), PC A04/MF A01		DE90753081	
88017	15:19616	NTIS (US Sales Only), PC A03/MF A01		DE90753093	
88020	15:19617	NTIS (US Sales Only), PC A03/MF A01		DE90753092	
88027	15:19618	NTIS (US Sales Only), PC A03/MF A01		DE90753097	
CRIE-Y–					
89002	15:19620	NTIS (US Sales Only), PC A03/MF A01		DE90753070	
CRIEPI-T–					
88087	15:19204	Central Research Institute of Electric Power Industry, Tokyo, Japan			
CRIEPI-U–					
88069	15:19253	Central Research Institute of Electric Power Industry, Tokyo, Japan			
DESY-SR–					
89-06	15:20197	Available from Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.)			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
DHHS/PUB/NIOSH–					
89-117	15:20436	*See* PB–90-125394/XAB			
DOE-RW–					
88.077	15:19345	Available from Radioactive Waste (Professional) Division. H.M. Inspectorate of Pollution. Department of the Environment. 2 Marshon Stre et. London SWIP 3EB			
88.085	15:20380	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90617506	
89.019	15:20381	NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS		DE90617507	
89.058	15:19346	NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS		DE90617938	
89.061	15:20353	NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS		DE90617490	
89.070	15:20788	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90617676	
DOE-tr–					
88-46	15:19716	NTIS, PC A13/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90002740	MF-900
88-47	15:19834	NTIS, PC A11/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90002742	MF-904
DOE/AL/10752–					
40	15:19336	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007377	MF-721
DOE/BC–					
89/2	15:19264	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89000763	PC-122
DOE/BC/10846–					
T1	15:19265	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007262	MF-122
DOE/CE–					
0210	15:19712	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006365	MF-330
DOE/CE/15325–					
T4	15:19509	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006700	MF-231
DOE/CE/33007–					
T2	15:19497	NTIS, PC A03/MF A01 - OSTI		DE90007186	MF-233
DOE/CH/10093–					
63	15:19510	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89009478	MF-233
75	15:19795	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000305	MF-310
DOE/DP–					
0061	15:19337	NTIS, PC A15/MF A01 - OSTI		DE90007192	MF-721
0062	15:19337	*See* DOE/DP–0061			
0063	15:19337	*See* DOE/DP–0061			
DOE/DP/10684–					
1	15:20972	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007552	MF-712
DOE/DP/40200–					
113	15:20973	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006806	MF-712
DOE/EH–					
0125-Vol.1	15:19422	NTIS, PC A20/MF A01 - OSTI		DE90006471	MF-630
0130	15:19423	NTIS, PC A99/MF A01 - OSTI		DE90006344	MF-630
0134	15:19254	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006375	MF-630
DOE/EIA–					
0035(89/11)	15:19703	NTIS, PC A07/MF A01 - GPO - OSTI; GPO Dep.	E 1.99:	DE90007201	MF-950
0121(89/3Q)	15:19251	NTIS, PC A07/MF A01 - GPO - OSTI; GPO Dep.	E 1.99:	DE90007350	MF-950
0206(88)	15:19278	NTIS, PC A08/MF A01 - GPO - OSTI; GPO Dep.	E 1.99:	DE90006865	MF-950
0226(89/11)	15:19727	NTIS, PC A08/MF A01 - GPO - OSTI; GPO Dep.	E 1.99:	DE90007357	MF-950
0380(89/11)	15:19279	NTIS, PC A08/MF A01 - GPO - OSTI; GPO Dep.	E 1.99:	DE90007123	MF-950
0527(90)	15:19714	NTIS, PC A06/MF A01 - GPO - OSTI; GPO Dep.	E 1.99:	DE90007086	MF-950
DOE/ER–					
0435	15:20656	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90005682	MF-414
0436	15:20067	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006449	MF-406
0438	15:19704	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006437	MF-400
DOE/ER/10495–					
T1	15:20742	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007416	MF-413
DOE/ER/10690–					
8	15:20661	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007083	MF-414
9	15:20662	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007084	MF-414
10	15:20663	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007082	MF-414
DOE/ER/10984–					
T5	15:19971	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007401	MF-401
DOE/ER/13132–					
T3	15:20086	NTIS, PC A02/MF A01 - OSTI		DE90007380	MF-406
DOE/ER/13387–					
70	15:20001	NTIS, PC A02/MF A01 - OSTI		DE90007418	MF-401

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DOE/ER/13429–5	15:20612	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007363	MF-411
DOE/ER/13545–3	15:19481	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007206	MF-401
DOE/ER/13548–T1	15:20644	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007294	MF-410
DOE/ER/13553–T3	15:20102	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006315	MF-406
DOE/ER/13630–3	15:20613	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007230	MF-411
DOE/ER/13647–T3	15:19988	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007426	MF-401
DOE/ER/13789–3	15:20012	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007659	MF-401
DOE/ER/13825–2	15:19989	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007345	MF-401
DOE/ER/13985–1	15:19847	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007365	MF-401
DOE/ER/25009–848	15:21100	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006324	MF-400
DOE/ER/30131–T9	15:20126	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007402	MF-406; MF-408
DOE/ER/40121–T3	15:20174	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007400	MF-420
DOE/ER/40160–6	15:20689	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007081	MF-414
DOE/ER/40226–5	15:20690	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007178	MF-414
DOE/ER/40339–3	15:20200	NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007234	MF-413
DOE/ER/40342–3	15:20727	NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007550	MF-413
DOE/ER/40376–3	15:20762	NTIS, PC A02/MF A01; OSTI; INIS		DE90007420	MF-413
DOE/ER/40451–2	15:20730	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007421	MF-413
DOE/ER/40452–3	15:20201	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006642	MF-413
DOE/ER/40509–1	15:20657	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007296	MF-414
DOE/ER/45113–5	15:19896	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007419	MF-404
DOE/ER/45120–10	15:19990	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007185	MF-401
DOE/ER/45156–T3	15:19936	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007557	MF-406
DOE/ER/45291–3	15:20797	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007080	MF-404
DOE/ER/45315–3	15:19848	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007428	MF-406
DOE/ER/45319–T1	15:20798	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007381	MF-410
DOE/ER/45325–3	15:19897	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007662	MF-406
DOE/ER/45356–3	15:19898	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007564	MF-404
DOE/ER/45368–2	15:19937	NTIS, PC A02/MF A01 - OSTI		DE90007179	MF-404
DOE/ER/52144–T1	15:20614	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007298	MF-420
DOE/ER/53276–T1	15:20850	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007551	MF-420
DOE/ET/32043–T29-Bk.1	15:19777	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006829	MF-528
T29-Bk.2	15:19778	NTIS, PC A99/MF A01 - OSTI		DE90006830	MF-528
DOE/ET/53051–148	15:20851	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007379	MF-426
DOE/ET/53088–413	15:20852	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007087	MF-427
415	15:20853	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007088	MF-427

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DOE/FC/10627–					
2799	15:19228	NTIS, PC A11/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000461	MF-109
DOE/FE–					
0157	15:19540	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008111	PC-101
0158	15:19541	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008110	PC-101
0159	15:19542	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008094	PC-101
0163	15:19173	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006448	MF-101
DOE/FE/61811–					
T1	15:19252	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007194	MF-101
DOE/FTR–					
90007398	15:19338	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007398	MF-702
DOE/ID–					
10086(88)	15:19339	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007405	MF-512
10087(88)	15:19418	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007020	MF-502
12082-88	15:19419	NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007240	MF-507
22083	15:19424	NTIS, PC A03/MF A01; OSTI; INIS; USGS-OFR, U.S.G.S. Open File Service, Box 25425, Denver Federal Center, Denver, CO 80225; GPO Dep.	E 1.99:	DE90006971	MF-502
DOE/ID/10368–					
1-Vol.1	15:19796	NTIS, PC A06/MF A01 - OSTI		DE90007195	MF-321
1-Vol.2	15:19700	NTIS, PC A15/MF A01 - OSTI		DE90007196	MF-321
DOE/ID/12557–					
3	15:20223	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007358	MF-310
DOE/ID/12726–					
1	15:19797	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007359	MF-310
DOE/ID/12735–					
T5	15:19734	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007333	MF-112; MF-114; MF-110
DOE/ID/12795–					
1	15:19798	NTIS, PC A13/MF A01 - OSTI		DE90006304	PC-310
DOE/IE–					
0016	15:19255	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006328	MF-930
DOE/LLW–					
78T	15:19340	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006965	MF-512
DOE/MA–					
0404	15:19705	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007846	MF-900
DOE/MC/11076–					
2789	15:19310	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000458	MF-123
DOE/MC/22009–					
2785	15:19295	NTIS, PC A11/MF A01 - OSTI		DE90000434	PC-132
DOE/MC/22062–					
2791-Vol.2	15:19174	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000445	MF-109
DOE/MC/22064–					
2796	15:19175	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000453	MF-109
DOE/MC/23086–					
2798	15:19176	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000460	MF-106
DOE/MC/23139–					
2794	15:19741	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000462	MF-110
DOE/MC/23256–					
2787-Vol.2	15:19833	NTIS, PC A05/MF A01 - OSTI		DE90000450	MF-111
DOE/MC/23259–					
2781	15:19196	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000435	PC-106
DOE/MC/24223–					
2792	15:19742	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000446	MF-110
DOE/METC–					
89/4090	15:19189	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89011697	MF-106
90/4095-Vol.1	15:19298	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000447	MF-132
90/4095-Vol.2	15:19299	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000448	MF-132
90/6109	15:19229	NTIS, PC A99/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000427	MF-109
DOE/NE/44139–					
59	15:19341	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007226	MF-510
DOE/NV/10418–					
2	15:19836	NTIS, PC A09/MF A01 - OSTI		DE90006819	MF-333
DOE/NV/10594–					
T1	15:20263	NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006340	MF-700
DOE/OR/21548–					
065	15:19425	NTIS, PC A07/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008103	MF-511
082-Rev.2	15:19752	NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007223	MF-511
109	15:19426	NTIS, PC A03/MF A01; OSTI; INIS		DE90007225	MF-511

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DOE/OR/21864–					
3	15:19342	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007180	MF-511
DOE/PC/79650–					
8	15:19230	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007602	MF-104
DOE/PC/79670–					
5	15:19735	NTIS, PC A12/MF A01 - OSTI		DE90004175	PC-112
DOE/PC/79909–					
9	15:19231	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007424	MF-104
DOE/PC/79914–					
T10	15:19190	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006790	MF-113
DOE/PC/80908–					
13	15:19177	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006942	MF-108
14	15:19178	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006878	MF-108
DOE/PC/88891–					
T3	15:19179	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006786	MF-102
DOE/PC/88913–					
T3	15:19232	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006953	MF-103
DOE/PC/88935–					
T4	15:19180	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008457	MF-108
DOE/PC/88951–					
4	15:19222	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006792	MF-114
DOE/PC/90013–					
T11	15:19472	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007188	MF-108
DOE/PC/90014–					
T6	15:19473	NTIS, PC A11/MF A01 - OSTI		DE90006498	PC-108
DOE/PC/90957–					
T8	15:19223	NTIS, PC A04/MF A01 - OSTI		DE90006497	PC-104; PC-114
DOE/RL–					
89-16-Draft-A	15:19343	NTIS, PC A16/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006345	MF-721
90-9	15:19344	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006473	MF-721
DOE/SF/16306–					
T2	15:19511	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007187	MF-231
DPST–					
82-389	15:19347	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007120	MF-721
DREO–					
1006	15:20241	*See* AD-A–214137/2/XAB			
E–					
4850	15:19903	*See* N–90-11881			
5084	15:19743	*See* N–90-11804			
5118	15:19942	*See* N–90-11880			
5148	15:19904	*See* N–90-11902			
5153	15:19626	*See* N–90-12696			
EA–					
333/89	15:19993	*See* OEFZS–4497			
ECN–					
89-184	15:19197	Netherlands Energy Research Foundation ECN, P.O. Box 1, 1755 ZG Petten, Netherlands			
89-187	15:19233	Netherlands Energy Research Foundation ECN, P.O. Box 1, 1755 ZG Petten, Netherlands			
EEG–					
26	15:19348	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007369	MF-721
27	15:19349	NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007368	MF-721
28	15:20068	NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007367	MF-721
40	15:19336	*See* DOE/AL/10752–40			
EEO-ED–					
107/170	15:19754	NTIS (US Sales Only), PC A03/MF A01		DE90752747	
179/59	15:19755	NTIS (US Sales Only), PC A04/MF A01		DE90752748	
200/223	15:19756	NTIS (US Sales Only), PC A03/MF A01		DE90752751	
208/245	15:19757	NTIS (US Sales Only), PC A03/MF A01		DE90752746	
227/209	15:19758	NTIS (US Sales Only), PC A04/MF A01		DE90752753	
250/212	15:19759	NTIS (US Sales Only), PC A03/MF A01		DE90752749	
37/89	15:19753	NTIS (US Sales Only), PC A04/MF A01		DE90752752	
EEO-RD–					
41/38	15:19760	NTIS (US Sales Only), PC A03/MF A01		DE90752750	
EGG–					
10617-1027	15:21115	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006757	MF-700
10617-1037	15:19280	NTIS, PC A10/MF A01 - OSTI		DE90007140	MF-706
10617-1039	15:19272	NTIS, PC A06/MF A01 - OSTI		DE90007136	MF-706
10617-1041	15:19273	NTIS, PC A03/MF A01 - OSTI		DE90007137	MF-706
10617-5009	15:20216	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006756	MF-700

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EGG-BNCT–					
8353-Vol.3-No.10	15:20451	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006954	MF-507
8353-Vol.3-No.11	15:20452	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006952	MF-507
8353-Vol.3-No.12	15:20453	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006986	MF-507
8353-Vol.3-No.8	15:20449	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007043	MF-408
8353-Vol.3-No.9	15:20450	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007044	MF-507
EGG-CS–					
8821	15:20974	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006964	MF-423
EGG-EAST–					
8491	15:20087	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006955	MF-520
8511	15:19573	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006970	MF-506
EGG-FSP–					
8653	15:20975	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006966	MF-407
8742	15:20976	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007040	MF-516
8766	15:20977	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007014	MF-423
EGG-HFRU–					
8705	15:19574	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006960	MF-523
EGG-M–					
88172	15:19575	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006948	MF-523
88176	15:19576	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006961	MF-523
88202	15:19577	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006963	MF-523
88237	15:19578	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006985	MF-523
88304	15:19579	NTIS (US Sales Only), PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007406	MF-523
88439	15:19580	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007045	MF-523
88493	15:19191	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006968	MF-102
89018	15:19581	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006962	
89020	15:20978	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006951	MF-700
89110	15:19181	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007011	MF-102
89205	15:20979	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007041	MF-425
89333	15:19350	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006972	MF-721
89410	15:19625	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007085	MF-331
89447	15:20095	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007415	MF-515
89475	15:19837	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007016	MF-333
89478	15:20069	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006958	
90001	15:19351	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006956	MF-523
90020	15:19352	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006949	MF-721
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8769	15:20454	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007290	MF-721
8770	15:19356	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007291	MF-721
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8504	15:19358	*See* EGG-WM–8689			
8661	15:19357	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006969	MF-510
8689	15:19358	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007022	MF-507
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8775	15:19359	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006984	MF-510
8802	15:19360	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006950	MF-721
EMR/CANMET–					
81-25(TR)	15:19799	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $0.34 CAN per page, $3.40 minimum; MF $10 CAN			
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430/09-89/008	15:20392	*See* PB–90-129263/XAB			
530/SW-90/009	15:20289	*See* PB–90-129362/XAB			
600/D-89/243	15:20287	*See* PB–90-129289/XAB			
600/D-89/246	15:20288	*See* PB–90-129297/XAB			
600/D-89/253	15:19815	*See* PB–90-129354/XAB			
600/J-88/437	15:20389	*See* PB–90-125915/XAB			
600/J-89/134	15:20387	*See* PB–90-125659/XAB			
600/J-89/135	15:20388	*See* PB–90-125667/XAB			

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600/J-89/167	15:20425	*See* PB–90-129529/XAB			
EPA-AA-TEB–					
89/03	15:19838	*See* PB–90-130402/XAB			
EPRI-CU–					
6606	15:19761	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6643	15:19762	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6690-Vol.1	15:19763	Research Reports Center, Box 50490, Palo Alto, CA 94303			
EPRI-EL–					
6634	15:19728	Research Reports Center, Box 50490, Palo Alto, CA 94303			
EPRI-GS–					
6620-Vol.1	15:19534	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6635	15:19535	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6642	15:19621	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6669	15:19477	Research Reports Center, Box 50490, Palo Alto, CA 94303			
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6673	15:19536	Research Reports Center, Box 50490, Palo Alto, CA 94303			
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6700	15:20354	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6704	15:19537	Research Reports Center, Box 50490, Palo Alto, CA 94303			
EPRI-GS/ER–					
6665	15:19538	Research Reports Center, Box 50490, Palo Alto, CA 94303			
EPRI-NP–					
6480-Vol.2	15:19610	*See* NUREG/CR–5395-Vol.2			
6698	15:19549	Research Reports Center, Box 50490, Palo Alto, CA 94303			
EPS–					
89-04698	15:20256	PC Environment Canada, Departmental Library, Ottawa, PQ, CAN K1A 0H3; MF CAN-MET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
ERIM–					
201600-11-F-VOL-1	15:20248	*See* AD-A–214243/8/XAB			
ERLN-N–					
056	15:20471	*See* PB–90-126046/XAB			
ES/ESH–					
8/V1	15:20266	NTIS, PC A14/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006438	MF-630
8/V2	15:20267	NTIS, PC A11/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006430	MF-630
8/V3	15:20356	NTIS, PC A09/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90005821	MF-630
ESC-WR–					
89-20	15:19543	Netherlands Energy Research Foundation ECN, P.O. Box 1, 1755 ZG Petten, Netherlands			
89-21	15:19701	Netherlands Energy Research Foundation ECN, P.O. Box 1, 1755 ZG Petten, Netherlands			
89-22	15:19779	Netherlands Energy Research Foundation ECN, P.O. Box 1, 1755 ZG Petten, Netherlands			
89-23	15:19303	Netherlands Energy Research Foundation ECN, P.O. Box 1, 1755 ZG Petten, Netherlands			
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ETN–					
89-95857	15:20587	*See* N–90-13296			
EUR–					
11749-EN	15:19224	Commission of the European Communities, Luxembourg			
12071-EN	15:19208	Commission of the European Communities, Luxembourg			

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12075-DE	15:19209	Commission of the European Communities, Luxembourg			
12083-EN	15:19210	Commission of the European Communities, Luxembourg			
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12168-ES	15:19212	Commission of the European Communities, Luxembourg			
12309-EN	15:19213	Commission of the European Communities, Luxembourg			
12310-DE	15:19214	Bergbau-Forschung GmbH, Essen (Germany, F.R.)			
12311-EN	15:19215	Commission of the European Communities, Luxembourg			
12313-DE	15:19216	Commission of the European Communities, Luxembourg			
12314-FR	15:19217	Commission of the European Communities, Luxembourg			
12315-DE	15:19160	Commission of the European Communities, Luxembourg			
12316-DE	15:19198	Commission of the European Communities, Luxembourg			
12361-EN	15:19225	Commission of the European Communities, Luxembourg			
EUR-CEA-FC–					
1362	15:20849	NTIS (US Sales Only), PC A05/MF A01			
1367	15:20834	NTIS (US Sales Only), PC A03/MF A01			
1368	15:20877	NTIS (US Sales Only), PC A03/MF A01			
1369	15:20878	NTIS (US Sales Only), PC A03/MF A01			
1370	15:20879	NTIS (US Sales Only), PC A03/MF A01			
1371	15:20880	NTIS (US Sales Only), PC A03/MF A01			
1372	15:20645	NTIS (US Sales Only), PC A08/MF A01			
FERMILAB-PUB–					
89/196-A	15:20586	*See* N–90-12492			
FNAL-TM–					
1635	15:20154	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006333	PC-414
1639	15:20175	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007233	PC-414
1642	15:20176	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006331	PC-414; PC-405
1643	15:20177	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006332	PC-414; PC-405
FNAL/C–					
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FhG-IWM-W–					
3/89	15:19849	NTIS (US Sales Only), PC A03/MF A01		DE90753177	
5/89	15:19850	NTIS (US Sales Only), PC A10/MF A01		DE90753176	
FhG-IzfP–					
840123-TW	15:20096	Copy held by UB/TIB Hannover			
GANIL-P–					
89-10	15:20733	NTIS (US Sales Only), PC A03/MF A01		DE90752559	
GEPP-EV–					
1193	15:20268	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006447	MF-702
GL-TR–					
89-0280	15:20600	*See* AD-A–214008/5/XAB			
89-0283	15:20599	*See* AD-A–214007/7/XAB			
GSF–					
4/89	15:19361	NTIS (US Sales Only), PC A11/MF A01		DE90753304	
7/87	15:20455	NTIS (US Sales Only), PC A09/MF A01		DE90753462	
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89-28	15:20179	NTIS (US Sales Only), PC A05/MF A01		DE90753486	
89-29	15:20180	Available from Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.)			
89-84(prepr.)	15:20835	NTIS (US Sales Only), PC A03/MF A01		DE90753572	
89-85(prepr.)	15:20753	NTIS (US Sales Only), PC A03/MF A01		DE90753573	
HAZ–					
CE02855	15:19281	Haztech Canada, 4936-87th St., no. 26, Edmonton, AB, CAN T6E 5W3. Prices: $50.00 CAN			
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HEDL-SA–					
3244	15:19899	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007244	MF-506
HETA–					
84-426-1963	15:20282	*See* PB–90-129057/XAB			
87-092-1967	15:20286	*See* PB–90-129107/XAB			
87-121-1968	15:19814	*See* PB–90-129016/XAB			
87-159-1962	15:20280	*See* PB–90-129024/XAB			
87-370-1973	15:20285	*See* PB–90-129099/XAB			
87-411-1972	15:20283	*See* PB–90-129073/XAB			
88-069	15:20279	*See* PB–90-128984/XAB			
88-077-1969	15:20281	*See* PB–90-129040/XAB			
88-082-1971	15:20284	*See* PB–90-129081/XAB			
88-266-1970	15:20435	*See* PB–90-129065/XAB			
88-328-1961	15:19813	*See* PB–90-129008/XAB			
HNEI–					
89-1004	15:19469	NTIS, PC A08/MF A01 - OSTI		DE90006885	MF-245
HW–					
12666-E	15:19427	NTIS, PC A03/MF A01 - OSTI		DE90007009	MF-600
12937-E	15:19428	NTIS, PC A03/MF A01 - OSTI		DE90007008	MF-600
13190-E	15:19429	NTIS, PC A03/MF A01 - OSTI		DE90007007	MF-600
13561-E	15:19430	NTIS, PC A03/MF A01 - OSTI		DE90007006	MF-600
13793-E	15:19431	NTIS, PC A03/MF A01 - OSTI		DE90007005	MF-600
14043-E	15:19432	NTIS, PC A03/MF A01 - OSTI		DE90007004	MF-600
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21506-E	15:19434	NTIS, PC A03/MF A01 - OSTI		DE90007032	MF-600
21802-E	15:19435	NTIS, PC A03/MF A01 - OSTI		DE90007031	MF-600
23140-E	15:20456	NTIS, PC A03/MF A01 - OSTI		DE90007030	MF-600
23178-Del.	15:19582	NTIS, PC A02/MF A01 - OSTI		DE90007029	MF-510
IA–					
169/88	15:19452	*See* OEFZS–4484			
IAEA-INFCIRC–					
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371	15:19447	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90617969	
372	15:19448	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90617970	
373	15:19449	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90617971	
97(Add.1)	15:19445	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90617972	
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IAEA-TECDOC–					
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527	15:20014	NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS		DE90617335	
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533	15:19314	NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS		DE90617372	
534	15:20881	NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS		DE90616822	
IEACR–					
19	15:19234	IEA Coal Research, 10-18 Putney Hill, London SW15 6AA, England			PC-103; PC-109; PC-101
IEE-SR–					
212	15:19718	NTIS (US Sales Only), PC A07/MF A01		DE90753072	
IFSR–					
413	15:20852	*See* DOE/ET/53088–413			
415	15:20853	*See* DOE/ET/53088–415			
IGT–					
61095	15:19179	*See* DOE/PC/88891–T3			
IKE–					
8-18	15:19682	NTIS (US Sales Only), PC A06/MF A01		DE90753471	
8-19	15:19683	NTIS (US Sales Only), PC A04/MF A01		DE90753445	

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IKF–					
48	15:20658	NTIS (US Sales Only), PC A07/MF A01		DE90753181	
ILR-Mitt.–					
215(1988)	15:19530	NTIS (US Sales Only), PC A10/MF A01		DE90753301	
INDC(CCP)–					
307/L	15:20763	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90617137	
309/N	15:20764	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90617134	
INDC(CPR)–					
15/L	15:20737	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90617152	
INDC(GDR)–					
056/L	15:20765	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90617138	
INDC(JPN)–					
131/L	15:20993	*See* JAERI-M–89-214			
INDC(NDS)–					
230/L	15:20728	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90617141	
INDC(TUK)–					
002/L	15:20766	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90617106	
INFO–					
0203-1	15:20382	NTIS (US Sales Only), PC A12/MF A01; OSTI; INIS		DE90617512	
0203-2	15:20383	NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS		DE90617513	
0203-3	15:20384	NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS		DE90617514	
0203-4	15:20385	NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS		DE90617515	
0248	15:20358	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90617555	
INIS-SU–					
151	15:20911	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90616858	
152/A	15:20912	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90616859	
153	15:20826	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90616935	
INIS-XN–					
201	15:19550	NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS		DE90617843	
INIS-mf–					
12514	15:20430	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90617580	
INP–					
1335/B	15:20458	NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS		DE90617556	
1341/PL	15:20615	NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS		DE90616684	
1346/PL	15:20459	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90617557	
1348/B	15:20359	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90617649	
IPEN-PUB–					
193	15:19991	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90617311	
213	15:20789	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90617678	
264	15:20042	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90617328	
269	15:20800	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90616726	
270	15:19972	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90617175	
271	15:20360	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90617492	
272	15:19973	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90617176	

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273	15:19562	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90617871	
274	15:20801	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90616727	
275	15:19974	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90617177	
276	15:20460	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90617548	
277	15:20043	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90617329	
278	15:19583	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90617844	
IPNO-TH–					
88-9	15:20836	NTIS (US Sales Only), PC A04/MF A01		DE90752603	
88-62	15:20691	NTIS (US Sales Only), PC A03/MF A01		DE90752609	
88-71	15:20716	NTIS (US Sales Only), PC A02/MF A01		DE90752608	
89-1	15:20717	NTIS (US Sales Only), PC A03/MF A01		DE90752610	
89-04	15:20692	NTIS (US Sales Only), PC A03/MF A01		DE90752611	
89-08	15:20837	NTIS (US Sales Only), PC A03/MF A01		DE90752607	
IPP–					
1/250	15:20991	NTIS (US Sales Only), PC A03/MF A01		DE90753675	
6/283	15:20913	NTIS (US Sales Only), PC A02/MF A01		DE90753674	
ISH–					
131	15:20044	Available from Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene			
IVL-B–					
931	15:20361	NTIS (US Sales Only), PC A04/MF A01		DE90748555	
IWGFR–					
71	15:19563	NTIS (US Sales Only), PC A17/MF A01 - OSTI		DE90006470	
IWS–					
146.13	15:20294	*See* PB–90-130055/XAB			
IYaF–					
89-13	15:20693	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90616981	
J–					
550-89-505/2513	15:20614	*See* DOE/ER/52144–T1			
JA–					
6165	15:19928	*See* AD-A–214152/1/XAB			
6202	15:20121	*See* AD-A–214151/3/XAB			
6225	15:20119	*See* AD-A–214064/8/XAB			
6265	15:20118	*See* AD-A–214063/0/XAB			
6308	15:20122	*See* AD-A–214155/4/XAB			
6340	15:20247	*See* AD-A–214150/5/XAB			
JAERI-M–					
89-122	15:20781	NTIS (US Sales Only), PC A05/MF A01		DE90749878	
89-127	15:20088	NTIS (US Sales Only), PC A04/MF A01		DE90749880	
89-154	15:20992	NTIS (US Sales Only), PC A09/MF A01		DE90749893	
89-214	15:20993	Japan Atomic Energy Research Inst., Tokai-mura, Naka-gun, Ibaraki-ken 319-11, Japan			
JNOC–					
8901	15:19256	NTIS (US Sales Only), PC A15/MF A01		DE90753073	
Juel–					
2238	15:20914	NTIS (US Sales Only), PC A03/MF A01		DE90753676	
2295	15:20767	NTIS (US Sales Only), PC A04/MF A01		DE90753664	
2299	15:19938	NTIS (US Sales Only), PC A05/MF A01		DE90753712	
2306	15:19564	NTIS (US Sales Only), PC A08/MF A01		DE90753302	
2309	15:19829	NTIS (US Sales Only), PC A05/MF A01		DE90753524	
Juel-Spez–					
521	15:19729	NTIS (US Sales Only), PC A03/MF A01		DE90753514	
K/DSRD–					
114	15:20228	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007108	
117	15:20229	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007110	
119	15:20230	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007189	
K/ITP–					
238	15:19443	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007111	MF-515
KFK–					
4623	15:20045	NTIS (US Sales Only), PC A15/MF A01		DE90753307	
4624	15:20469	NTIS (US Sales Only), PC A08/MF A01		DE90753306	
4632	15:20203	NTIS (US Sales Only), PC A05/MF A01		DE90753601	
4633	15:19362	NTIS (US Sales Only), PC A10/MF A01		DE90753309	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
4634	15:19975	NTIS (US Sales Only), PC A03/MF A01		DE90753279	
4639	15:19976	NTIS (US Sales Only), PC A03/MF A01		DE90753509	
4644	15:21101	NTIS (US Sales Only), PC A03/MF A01		DE90753508	
4658	15:19584	NTIS (US Sales Only), PC A05/MF A01		DE90753600	
4663	15:19551	NTIS (US Sales Only), PC A06/MF A01		DE90753599	
KU-HCOE-FL2-R–					
88-5	15:20803	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90616729	
88-6	15:20804	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90616797	
88-7	15:20805	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90616798	
88-9	15:19851	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90617448	
88-10	15:20806	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90616796	
88-11	15:20807	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90616728	
89-8	15:20808	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90616734	
89-9	15:20809	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90616735	
89-10	15:20810	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90616730	
89-11	15:20811	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90616731	
89-12	15:20812	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90616732	
89-13	15:20827	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90616936	
89-15	15:20813	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90616733	
KURRI-TR–					
322	15:20097	NTIS (US Sales Only), PC A03/MF A01		DE90749895	
L–					
16350-PT-1	15:20089	*See* N–90-12503			
16350-PT-2	15:20090	*See* N–90-12519			
16350-PT-3	15:20092	*See* N–90-12539			
LA–					
11628-ENV	15:20362	NTIS, PC A11/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006405	PC-702; PC-707
11680-MS	15:20782	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006347	MF-905; MF-910
11695	15:19363	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007376	MF-701
11723-MS	15:19841	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006977	MF-904
11725-MS	15:20616	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009041	MF-700
11750-MS	15:20231	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006476	MF-700
11756-PR	15:19780	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006436	MF-528; MF-830
11777-MS	15:19781	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007688	MF-900
218/89	15:20364	*See* OEFZS-A–1499			
221/89	15:20365	*See* OEFZS-A–1526			
LA-UR–					
89-3013	15:20492	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000538	
89-3386	15:20768	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90002390	MF-413
89-3575	15:20838	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90002414	MF-910
89-3858	15:19782	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90003662	MF-900
89-4151	15:19444	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90004843	MF-721
89-669	15:20127	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007506	MF-706
90-1	15:20769	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006483	MF-413
90-3	15:20720	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006484	MF-410
90-112	15:19900	NTIS, PC A03/MF A01 - OSTI		DE90007889	MF-401; MF-406
90-13	15:19364	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006486	MF-810
90-134	15:20665	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008635	MF-414
90-158	15:20697	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006515	MF-414
90-161	15:20128	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006517	MF-906
90-165	15:19939	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006518	MF-906; MF-901
90-170	15:20212	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008637	MF-706
90-176	15:20617	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008636	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
90-183	15:19366	NTIS, PC A03/MF A01; OSTI; INIS		DE90006503	MF-814
90-196	15:19992	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006516	MF-403
90-23	15:19852	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007832	MF-904
90-24	15:19853	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006489	MF-904
90-25	15:19854	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006490	MF-904
90-255	15:20234	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006509	MF-741
90-296	15:20249	NTIS, PC A02/MF A01 - OSTI		DE90006511	
90-315	15:20155	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006544	MF-410
90-351	15:19367	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006512	MF-810
90-353	15:19368	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006513	MF-810
90-356	15:21102	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007546	MF-906
90-379	15:21103	NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007488	MF-905
90-383	15:20181	NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007489	MF-414; MF-405
90-42	15:20530	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006522	MF-700
90-443	15:19783	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007625	MF-700
90-452	15:20994	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007529	MF-413
90-456	15:20250	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007530	MF-706
90-459	15:19855	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007531	MF-704
90-493	15:20729	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007535	MF-910
90-496	15:20129	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007536	MF-706
90-539	15:20646	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007541	MF-910
90-540	15:21104	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007542	MF-905
90-599	15:20995	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007545	MF-712
90-608	15:20915	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007490	MF-910
90-627	15:21105	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007492	MF-905
90-654	15:19856	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007502	
90-655	15:20130	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007503	MF-706
90-660	15:19857	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007504	MF-704
90-668	15:20814	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007505	MF-706
90-68	15:19365	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007826	MF-814
90-696	15:20131	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007508	MF-906
90-714	15:21106	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007511	MF-705
LAPP-TH–					
208-88	15:20718	NTIS (US Sales Only), PC A03/MF A01		DE90752605	
213-88	15:20694	NTIS (US Sales Only), PC A03/MF A01		DE90752601	
214-88	15:20695	NTIS (US Sales Only), PC A03/MF A01		DE90752602	
222-88	15:20719	NTIS (US Sales Only), PC A03/MF A01		DE90752600	
226-88	15:20696	NTIS (US Sales Only), PC A02/MF A01		DE90752604	
LBF-FB–					
185(1989)	15:19858	NTIS (US Sales Only), PC A04/MF A01		DE90753285	
LBL–					
25959	15:20217	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007068	
25960	15:20218	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006981	MF-406
27775	15:19859	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007062	MF-404
27911	15:19977	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007407	MF-401; MF-402
27953	15:20182	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007067	MF-414
27965	15:20183	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006096	MF-414
28076	15:20002	NTIS, PC A10/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007349	MF-400; MF-406
28085	15:20003	NTIS, PC A22/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007064	MF-404
28096	15:19940	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007063	MF-404
28106	15:20153	NTIS, PC A07/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006982	MF-414
28113	15:20184	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007066	MF-426
28127	15:20013	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007079	MF-401
28141	15:20204	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007077	MF-414
28170	15:19860	NTIS, PC A09/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007348	MF-404
28171	15:19257	NTIS, PC A09/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007347	MF-406
28193	15:19941	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007078	MF-404
28252	15:20462	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007061	MF-407
28305	15:19901	NTIS, PC A02/MF A01 - OSTI		DE90007075	MF-406
LC–					
88-31544	15:20270	*See* N–90-12101			
LPI-CONTRIB–					
708	15:20532	*See* N–90-12423			
LRP–					
379/89	15:20916	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90616874	
MI–					
102/89	15:20364	*See* OEFZS-A–1499			

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103/89	15:20365	*See* OEFZS-A–1526			
MICROLOG–					
89-04698	15:20256	*See* EPS–89-04698			
89-05075	15:19799	*See* EMR/CANMET–81-25(TR)			
89-05075	15:19800	*See* EMR/CANMET–81-25(TR)			
MISC–					
89118	15:19339	*See* DOE/ID–10086(88)			
89121	15:19424	*See* DOE/ID–22083			
89152	15:19418	*See* DOE/ID–10087(88)			
90003	15:19340	*See* DOE/LLW–78T			
MIT/LCS/TM–					
402	15:21086	*See* AD-A–214035/8/XAB			
MIT/LCS/TR–					
443	15:21087	*See* AD-A–214112/5/XAB			
MLM–					
3620	15:19586	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005813	PC-700
3624-OP	15:19454	NTIS, PC A02/MF A01 - OSTI		DE90007147	MF-706
3625-OP	15:19738	NTIS, PC A02/MF A01 - OSTI		DE90007149	MF-706
MPE-PREPRINT–					
155	15:20587	*See* N–90-13296			
MTI–					
89TR40	15:20072	*See* N–90-12935			
MTL-TR–					
89-79	15:19885	*See* AD-A–214347/7/XAB			
N–					
90-11804	15:19743	NTIS, PC A03/MF A01			
90-11807	15:19902	NTIS, PC A07/MF A01			
90-11825	15:20051	NTIS, PC A05/MF A01			
90-11853	15:19861	NTIS, PC A11/MF A02			
90-11880	15:19942	NTIS, PC A03/MF A01			
90-11881	15:19903	NTIS, PC A03/MF A01			
90-11902	15:19904	NTIS, PC A02/MF A01			
90-12009	15:19943	NTIS, PC A03/MF A01			
90-12059	15:20269	NTIS, PC A05/MF A01			
90-12090	15:20363	NTIS, PC A03/MF A01			
90-12101	15:20270	NTIS, PC A07/MF A01			
90-12298	15:20531	NTIS, PC A04/MF A01			
90-12345	15:19944	NTIS, PC A03/MF A01			
90-12423	15:20532	NTIS, PC A04/MF A01			
90-12458	15:20553	NTIS, PC A03/MF A01			
90-12459	15:20554	NTIS, PC A17/MF A03			
90-12492	15:20586	NTIS, PC A03/MF A01			
90-12503	15:20089	NTIS, PC A14/MF A02			
90-12519	15:20090	NTIS, PC A15/MF A02			
90-12539	15:20092	NTIS, PC A17/MF A03			
90-12696	15:19626	NTIS, PC A03/MF A01			
90-12715	15:19862	NTIS, PC A03/MF A01			
90-12935	15:20072	NTIS, PC A05/MF A01			
90-13228	15:20271	NTIS, PC A06/MF A01			
90-13296	15:20587	NTIS, PC A04/MF A01			
90-13316	15:20588	NTIS, PC A03/MF A01			
NAS–					
1.15:100357	15:20269	*See* N–90-12059			
1.15:100380	15:19944	*See* N–90-12345			
1.15:101893	15:20554	*See* N–90-12459			
1.15:102088	15:19903	*See* N–90-11881			
1.15:102366	15:19743	*See* N–90-11804			
1.15:102379	15:19942	*See* N–90-11880			
1.15:102398	15:19904	*See* N–90-11902			
1.15:102399	15:19626	*See* N–90-12696			
1.15:4153	15:20363	*See* N–90-12090			
1.15:86494	15:19862	*See* N–90-12715			
1.26:182366	15:20051	*See* N–90-11825			
1.26:183807	15:20072	*See* N–90-12935			
1.26:184999	15:19902	*See* N–90-11807			
1.26:185144	15:19861	*See* N–90-11853			
1.26:185323	15:20270	*See* N–90-12101			
1.26:185432	15:20532	*See* N–90-12423			
1.26:185451	15:20588	*See* N–90-13316			
1.26:185497	15:20587	*See* N–90-13296			
1.26:185832	15:19943	*See* N–90-12009			

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1.26:185924	15:20586	*See* N–90-12492			
1.26:185982	15:20553	*See* N–90-12458			
1.26:185983	15:20531	*See* N–90-12298			
1.26:4262	15:20271	*See* N–90-13228			
1.55:2487-PT-1	15:20089	*See* N–90-12503			
1.55:2487-PT-2	15:20090	*See* N–90-12519			
1.55:2487-PT-3	15:20092	*See* N–90-12539			
NASA-CP–					
2487-PT-1	15:20089	*See* N–90-12503			
2487-PT-2	15:20090	*See* N–90-12519			
2487-PT-3	15:20092	*See* N–90-12539			
NASA-CR–					
182366	15:20051	*See* N–90-11825			
183807	15:20072	*See* N–90-12935			
184999	15:19902	*See* N–90-11807			
185144	15:19861	*See* N–90-11853			
185323	15:20270	*See* N–90-12101			
185432	15:20532	*See* N–90-12423			
185451	15:20588	*See* N–90-13316			
185497	15:20587	*See* N–90-13296			
185832	15:19943	*See* N–90-12009			
185924	15:20586	*See* N–90-12492			
185982	15:20553	*See* N–90-12458			
185983	15:20531	*See* N–90-12298			
4262	15:20271	*See* N–90-13228			
NASA-TM–					
100357	15:20269	*See* N–90-12059			
100380	15:19944	*See* N–90-12345			
101893	15:20554	*See* N–90-12459			
102088	15:19903	*See* N–90-11881			
102366	15:19743	*See* N–90-11804			
102379	15:19942	*See* N–90-11880			
102398	15:19904	*See* N–90-11902			
102399	15:19626	*See* N–90-12696			
4153	15:20363	*See* N–90-12090			
86494	15:19862	*See* N–90-12715			
NATICK/TR–					
88/046	15:19459	*See* AD-A–214111/7/XAB			
NEANDC(J)–					
144/U	15:20993	*See* JAERI-M–89-214			
NEDOJ-P–					
8818	15:19711	NTIS (US Sales Only), PC A06/MF A01		DE90753152	
8820	15:20272	NTIS (US Sales Only), PC A06/MF A01		DE90753153	
NEI-NO–					
101	15:19266	NTIS (US Sales Only), PC A21/MF A01		DE90748476	
71	15:20493	NTIS (US Sales Only), PC A14/MF A01		DE90748509	
NERDDP-EG–					
89-804	15:19161	Department of Resources and Energy, GPO Box 858, Canberra, ACT 2601, Australia			
89-810	15:19218	Department of Resources and Energy, GPO Box 858, Canberra, ACT 2601, Australia			
89-816	15:19236	Department of Resources and Energy, GPO Box 858, ACT 2601, Australia			
89-821	15:19219	Department of Resources and Energy, GPO Box 858, ACT 2601, Australia			
89-838	15:19220	Department of Resources and Energy, GPO Box 858, ACT 2601, Australia			
NIPER–					
444	15:19261	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000222	PC-122
450	15:20386	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000223	PC-122
458	15:19268	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000224	PC-122
NPL-RSA(EXT)–					
3	15:20790	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90617663	
NPS–					
52-89-040	15:19775	*See* AD-A–214181/0/XAB			
61-89-014	15:20601	*See* AD-A–214013/5/XAB			
NRL-MR–					
6527	15:20602	*See* AD-A–214130/7/XAB			
NU–					
103/89	15:20364	*See* OEFZS-A–1499			

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112/89	15:20365	*See* OEFZS-A–1526			
NUKEM-FuE–					
88042	15:19369	NTIS (US Sales Only), PC A05/MF A01		DE90753305	
NUREG–					
0020-Vol.14-No.1	15:19545	NTIS, PC A22/MF A01 - GPO; OSTI, INIS		TI90007164	
0040-Vol.13-No.4	15:19556	NTIS, PC A05/MF A01 - GPO; OSTI; INIS		TI90007173	
0750-Vol.30-No.4	15:19557	NTIS, PC A05/MF A01 - GPO; OSTI; INIS		TI90006919	
0797-Suppl.22	15:19587	NTIS, PC A16/MF A01 - GPO; OSTI; INIS		TI90006728	
1232-Vol.4	15:19588	NTIS, PC A05/MF A01 - GPO; OSTI; INIS		TI90006724	
NUREG/CR–					
3145-Vol.8	15:19608	NTIS, PC E04/MF E01 - GPO - OSTI		TI90007274	
4674-Vol.9	15:19609	NTIS, PC A08/MF A01 - GPO; OSTI; INIS		TI90007408	
4744-Vol.3-No.1	15:19547	NTIS, PC A04/MF A01 - GPO; OSTI; INIS		TI90007411	
5395-Vol.2	15:19610	NTIS, PC E20/MF E09 - GPO; OSTI; INIS		TI90007165	
5419	15:19611	NTIS, PC A07/MF A01 - GPO; OSTI; INIS		TI90006727	
5472	15:19612	NTIS, PC A08/MF A01 - GPO; OSTI; INIS		TI90006779	
5482	15:19370	NTIS, PC A15/MF A01 - GPO - OSTI		TI90007204	
5512	15:20463	NTIS, PC A14/MF A01 - GPO; OSTI; INIS		TI90007166	
5516	15:20464	NTIS, PC A03/MF A01 - GPO; OSTI; INIS		TI90007410	
NUS–					
5235-Bk.1	15:19784	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006826	MF-528
5235-Bk.2	15:19785	NTIS, PC A09/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006827	MF-528
5238	15:19786	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006828	MF-528
OEFZS–					
4484	15:19452	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90617792	
4497	15:19993	NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS		DE90617280	
4499	15:19436	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90617643	
4500	15:20206	NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS		DE90617878	
4506	15:20465	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90617558	
OEFZS-A–					
1444	15:19437	Available from the Austrian Research Centre Seibersdorf, A-2444 Seibersdorf (Austria)			
1469	15:19863	Available from the Austrian Research Centre Seibersdorf, A-2444 Seibersdorf (Austria)			
1499	15:20364	Available from the Austrian Research Centre Seibersdorf, A-2444 Seibersdorf (Austria)			
1526	15:20365	Available from the Austrian Research Centre Seibersdorf, A-2444 Seibersdorf (Austria)			
ORNL–					
6483	15:19864	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007609	MF-365
6516	15:20647	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006474	MF-405
6526/R11	15:20366	NTIS, PC A06/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006433	MF-630
6541/V2/P1	15:19706	NTIS, PC A09/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006434	MF-400
6541/V2/P2	15:19707	NTIS, PC A09/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006435	MF-400
6554	15:19613	NTIS, PC A15/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006441	PC-523
6582	15:20724	NTIS, PC A15/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006440	PC-413
ORNL/ATD–					
28/V1	15:20996	NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90005818	MF-422
ORNL/CF–					
87/263	15:21084	*See* ORNL/TM–10817			
ORNL/DSRD/TM–					
46	15:20232	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006432	
ORNL/FTR–					
3522	15:20839	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007375	MF-410
3524	15:19810	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007373	MF-350
3525	15:19731	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007432	MF-350
3526	15:19371	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007235	MF-402
3527	15:20815	NTIS, PC A03/MF A01 - OSTI		DE90007374	MF-410
3529	15:19865	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007422	MF-404
3538	15:20997	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007486	MF-423
ORNL/M–					
1002	15:20257	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007107	MF-408
1067	15:19766	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007190	MF-350
828	15:21107	NTIS, PC A10/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005815	MF-705
915	15:19567	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006729	MF-400

ORNL/NOAC–

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ORNL/NOAC–					
232-Vol.9	15:19609	*See* NUREG/CR–4674-Vol.9			
ORNL/OMIS–					
89/9	15:20618	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006372	MF-410
ORNL/Sub–					
85-55904/02	15:19182	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006722	MF-114
88-SA407/1	15:19767	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005819	MF-350
ORNL/TM–					
10742	15:19372	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90005817	MF-721
10817	15:21084	NTIS, PC A04/MF A01 - OSTI		DE90006427	MF-900
11016	15:20074	NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006444	PC-810; PC-812; PC-820; PC-510;
11024	15:20233	NTIS, PC A03/MF A01 - OSTI		DE90006429	
11361	15:19787	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006428	MF-400
11407	15:19373	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006442	PC-512
11416	15:19374	NTIS, PC A18/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90005816	MF-721
11418	15:19905	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005820	MF-332
11428	15:20132	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005822	MF-900
OZ–					
89/2	15:20710	*See* UM-P–89/03			
PATENTS-USA–					
4,867,868	15:19162	Patent and Trademark Office, Box 9, Washington, DC 20232			
4,869,625	15:19263	Patent and Trademark Office, Box 9, Washington, DC 20232			
4,870,295	15:19496	Patent and Trademark Office, Box 9, Washington, DC 20232			
4,868,072	15:19737	Patent and Trademark Office, Box 9, Washington, DC 20232			
4,867,866	15:19831	Patent and Trademark Office, Box 9, Washington, DC 20232			
4,854,173	15:19883	Patent and Trademark Office, Box 9, Washington, DC 20232			
Application7-389,220	15:19927	NTISPC N03/MF A01			
4,868,768	15:19984	Patent and Trademark Office, Box 9, Washington, DC 20232			
4,867,951	15:19985	Patent and Trademark Office, Box 9, Washington, DC 20232			
4,864,652	15:20344	Patent and Trademark Office, Box 9, Washington, DC 20232			
PATENTS-A7-441,912	15:20420	NTISPC N03/MF A01			
PATENTS-USA–					
Application7-437,819	15:20421	NTISPC N03/MF A01			
4,871,527	15:20431	Patent and Trademark Office, Box 9, Washington, DC 20232			
Application7-429,033	15:20487	NTISPC N03/MF A01			
Application7-408,970	15:21113	NTISPC N03/MF A01			
PB–					
90-122128/XAB	15:19699	NTIS, PC A16/MF A02			
90-125394/XAB	15:20436	NTIS, PC A10/MF A02			
90-125659/XAB	15:20387	NTIS, PC A02/MF A01			
90-125667/XAB	15:20388	NTIS, PC A03/MF A01			
90-125675/XAB	15:20273	NTIS, PC A03/MF A01			
90-125717/XAB	15:20274	NTIS, PC A03/MF A01			
90-125865/XAB	15:20275	NTIS, PC A03/MF A01			
90-125873/XAB	15:20470	NTIS, PC A02/MF A01			
90-125915/XAB	15:20389	NTIS, PC A03/MF A01			
90-126004/XAB	15:20276	NTIS, PC A04/MF A01			
90-126012/XAB	15:20277	NTIS, PC A06/MF A01			
90-126038/XAB	15:20278	NTIS, PC A07/MF A01			
90-126046/XAB	15:20471	NTIS, PC A03/MF A01			
90-126665/XAB	15:20367	NTIS, PC A04/MF A01			
90-127366/XAB	15:19811	NTIS, PC A06/MF A01			
90-127473/XAB	15:19812	NTIS, PC A09/MF A01			
90-127580/XAB	15:19460	NTIS, PC A11/MF A02			
90-127614/XAB	15:19465	NTIS, PC A05/MF A01			
90-127978/XAB	15:20472	NTIS, PC A02/MF A01			

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90-128000/XAB	15:20473	NTIS, PC A03/MF A01			
90-128018/XAB	15:20390	NTIS, PC A02/MF A01			
90-128984/XAB	15:20279	NTIS, PC A03/MF A01			
90-129008/XAB	15:19813	NTIS, PC A03/MF A01			
90-129016/XAB	15:19814	NTIS, PC A03/MF A01			
90-129024/XAB	15:20280	NTIS, PC A03/MF A01			
90-129040/XAB	15:20281	NTIS, PC A03/MF A01			
90-129057/XAB	15:20282	NTIS, PC A03/MF A01			
90-129065/XAB	15:20435	NTIS, PC A03/MF A01			
90-129073/XAB	15:20283	NTIS, PC A03/MF A01			
90-129081/XAB	15:20284	NTIS, PC A03/MF A01			
90-129099/XAB	15:20285	NTIS, PC A03/MF A01			
90-129107/XAB	15:20286	NTIS, PC A03/MF A01			
90-129149/XAB	15:20391	NTIS, PC A05/MF A01			
90-129263/XAB	15:20392	NTIS, PC A03/MF A01			
90-129271/XAB	15:20474	NTIS, PC A03/MF A01			
90-129289/XAB	15:20287	NTIS, PC A03/MF A01			
90-129297/XAB	15:20288	NTIS, PC A02/MF A01			
90-129313/XAB	15:20393	NTIS, PC A03/MF A01			
90-129321/XAB	15:20394	NTIS, PC A03/MF A01			
90-129347/XAB	15:20395	NTIS, PC A03/MF A01			
90-129354/XAB	15:19815	NTIS, PC A03/MF A01			
90-129362/XAB	15:20289	NTIS, PC A05/MF A01			
90-129370/XAB	15:20290	NTIS, PC A02/MF A01			
90-129396/XAB	15:20475	NTIS, PC A03/MF A01			
90-129404/XAB	15:20291	NTIS, PC A02/MF A01			
90-129412/XAB	15:20476	NTIS, PC A01/MF A01			
90-129438/XAB	15:20410	NTIS, PC A03/MF A01			
90-129495/XAB	15:20424	NTIS, PC A02/MF A01			
90-129503/XAB	15:20433	NTIS, PC A02/MF A01			
90-129511/XAB	15:20477	NTIS, PC A02/MF A01			
90-129529/XAB	15:20425	NTIS, PC A02/MF A01			
90-129701/XAB	15:19287	NTIS, PC EE99/MF E99			
90-129719/XAB	15:19288	NTIS, PC A02/MF A01			
90-129727/XAB	15:19289	NTIS, PC A02/MF A01			
90-129735/XAB	15:19290	NTIS, PC A23/MF A03			
90-129743/XAB	15:19291	NTIS, PC A21/MF A03			
90-129750/XAB	15:19292	NTIS, PC A18/MF A03			
90-129768/XAB	15:19293	NTIS, PC A06/MF A01			
90-129776/XAB	15:19294	NTIS, PC A25/MF A03			
90-129800/XAB	15:20396	NTIS, PC A03/MF A01			
90-129842/XAB	15:20478	NTIS, PC A03/MF A01			
90-129883/XAB	15:20479	NTIS, PC A03/MF A01			
90-129925/XAB	15:19768	NTIS, PC A04/MF A01			
90-129941/XAB	15:20292	NTIS, PC A03/MF A01			
90-129958/XAB	15:19296	NTIS, PC A04/MF A01			
90-129966/XAB	15:19297	NTIS, PC A03/MF A01			
90-129974/XAB	15:19769	NTIS, PC A03/MF A01			
90-130048/XAB	15:20293	NTIS, PC A01/MF A01			
90-130055/XAB	15:20294	NTIS, PC A03/MF A01			
90-130063/XAB	15:20295	NTIS, PC A03/MF A01			
90-130071/XAB	15:20296	NTIS, PC A02/MF A01			
90-130329/XAB	15:19306	NTIS, PC A03/MF A01			
90-130402/XAB	15:19838	NTIS, PC A03/MF A01			
90-133364/XAB	15:19702	NTIS, PC A08/MF A01			
90-138512/XAB	15:20133	NTIS, PC A05/MF A01			
90-500752/XAB	15:20297	NTISCP D01			
90-500760/XAB	15:20298	NTISCP D02			
90-500778/XAB	15:20299	NTISCP D01			
90-500786/XAB	15:20300	NTISCP D01			
90-500794/XAB	15:20301	NTISCP D01			
90-500810/XAB	15:20302	NTISCP D01			
90-500828/XAB	15:20303	NTISCP D01			
90-500836/XAB	15:20304	NTISCP D01			
90-500844/XAB	15:20305	NTISCP D01			
90-500851/XAB	15:20306	NTISCP D01			
90-500869/XAB	15:20307	NTISCP D01			
90-500877/XAB	15:20308	NTISCP D02			
90-853748/XAB	15:20411	NTISPC N01/MF N01			
90-853763/XAB	15:20412	NTISPC N01/MF N01			
90-853987/XAB	15:20397	NTISPC N01/MF N01			

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90-854050/XAB	15:20413	NTISPC N01/MF N01			
90-854357/XAB	15:20437	NTISPC N01/MF N01			
90-854415/XAB	15:19816	NTISPC N01/MF N01			
90-854423/XAB	15:20480	NTISPC N01/MF N01			
90-854449/XAB	15:19978	NTISPC N01/MF N01			
90-854456/XAB	15:19979	NTISPC N01/MF N01			
90-854506/XAB	15:19980	NTISPC N01/MF N01			
90-854522/XAB	15:20438	NTISPC N01/MF N01			
90-854589/XAB	15:19866	NTISPC N01/MF N01			
90-854597/XAB	15:19817	NTISPC N01/MF N01			
90-854605/XAB	15:19835	NTISPC N01/MF N01			
90-854621/XAB	15:19945	NTISPC N01/MF N01			
90-854738/XAB	15:20309	NTISPC N01/MF N01			
90-854746/XAB	15:20490	NTISPC N01/MF N01			
90-854795/XAB	15:19946	NTISPC N01/MF N01			
90-854928/XAB	15:20098	NTISPC N01/MF N01			
90-854944/XAB	15:19270	NTISPC N01/MF N01			
90-855024/XAB	15:19271	NTISPC N01/MF N01			
90-855057/XAB	15:20398	NTISPC N01/MF N01			
90-855065/XAB	15:19818	NTISPC N01/MF N01			
90-855289/XAB	15:20399	NTISPC N01/MF N01			
90-855339/XAB	15:19205	NTISPC N01/MF N01			
90-855347/XAB	15:19206	NTISPC N01/MF N01			
90-855495/XAB	15:19819	NTISPC N01/MF N01			
90-855503/XAB	15:20400	NTISPC N01/MF N01			
90-855537/XAB	15:20134	NTISPC N01/MF N01			
90-855545/XAB	15:20135	NTISPC N01/MF N01			
90-855578/XAB	15:19947	NTISPC N01/MF N01			
PH–					
468/89	15:19436	*See* OEFZS–4499			
472/89	15:19863	*See* OEFZS-A–1469			
474/89	15:20364	*See* OEFZS-A–1499			
478/89	15:20365	*See* OEFZS-A–1526			
PNL–					
6640-Vol.2	15:19375	NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006477	MF-812
6971	15:19770	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007606	MF-350
7202	15:19820	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006978	MF-900
7212	15:20463	*See* NUREG/CR–5512			
7215	15:20401	NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90005826	MF-802
7217	15:20464	*See* NUREG/CR–5516			
7222-Vols.1-2	15:19376	NTIS, PC E13/MF E01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007499	MF-903
7230	15:19627	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005810	MF-212
7241	15:20368	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006979	MF-402
7251	15:19438	NTIS, PC A05/MF A01 - OSTI		DE90007100	MF-402
7252	15:19439	NTIS, PC A06/MF A01; OSTI; INIS		DE90007102	MF-402
7269	15:19788	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007844	
PPA-A–					
79	15:19453	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90617787	
PPA-AL–					
9	15:19559	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90617820	
10	15:19710	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90617948	
PPPL–					
2671	15:20917	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90005814	PC-420; PC-426
2677	15:20998	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006348	PC-420
PSI–					
35	15:20369	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90615971	
44	15:19377	Published also in Werkstoffe u. Korrosion v. 39 p. 185-192, 283-286, 332-338 (1988), v. 40 p. 441-447 (1989).			
48	15:19451	NTIS (US Sales Only), PC A09/MF A01 - OSTI; INIS		DE90614726	
49	15:20756	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90615628	
51	15:20093	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90617793	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
PTB-Dos–					
18	15:20207	NTIS (US Sales Only), PC A03/MF A01		DE90753662	
PTB-Ra–					
23	15:20208	NTIS (US Sales Only), PC A03/MF A01		DE90753663	
RAL–					
89-042	15:20698	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90616952	
REPT–					
90-005	15:20363	*See* N–90-12090			
RFP–					
4280	15:20094	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008102	PC-706
4388	15:19378	NTIS, PC A - OSTI; GPO Dep.	E 1.99:	DE90007292	MF-701
RHO-BW-SA–					
291	15:19420	OSTI; INIS		TI90006858	MF-813
297	15:19381	OSTI; INIS		TI90006859	MF-813
RHO-BWI-SA–					
140	15:19379	OSTI; INIS		TI90006609	MF-813
312	15:19380	OSTI; INIS		TI90006860	MF-813
SAAS–					
378	15:20792	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90617679	
SAIC–					
87/3044-APPAT-91	15:20918	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007267	MF-420
SAN–					
16306-9	15:19511	*See* DOE/SF/16306–T2			
SAND–					
88-0882	15:19382	NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006368	MF-814
88-2845C	15:19383	NTIS, PC A03/MF A01 - OSTI		DE90005954	MF-721
88-2958	15:21108	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006467	MF-905
88-3402	15:20075	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006431	MF-700
89-0077	15:21109	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006466	MF-705
89-0209/1	15:21116	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005824	MF-700
89-0209/3	15:20076	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008114	MF-700
89-0753C	15:20077	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016179	MF-706
89-1500C	15:19514	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000801	MF-235
89-1506C	15:19480	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90003949	MF-231
89-1582C	15:19502	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016537	MF-336
89-1658C	15:19789	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006478	MF-706
89-1712C	15:19948	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007276	MF-701
89-1811C	15:19482	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90004211	MF-234
89-1890	15:20185	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006366	MF-910
89-1971	15:20236	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006464	MF-705
89-1980C	15:20224	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006959	MF-706
89-1988C	15:20370	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90005402	
89-2018C	15:19384	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90004210	MF-814
89-2023C	15:19183	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006045	MF-706
89-2026C	15:19385	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016496	MF-721
89-2050C	15:19386	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005401	MF-721
89-2052C	15:20078	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90000844	MF-722
89-2073C	15:19387	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90005597	MF-814
89-2098C	15:19388	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90005596	MF-814
89-2099C	15:19389	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90005238	MF-814
89-2140C	15:19790	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007429	MF-706
89-2250C	15:20079	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006019	MF-706
89-2263C	15:20080	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006809	MF-820
89-2349C	15:19390	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006538	MF-722
89-2360C	15:19503	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90002907	MF-235
89-2400	15:19184	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008098	MF-108; MF-114
89-2512C	15:19949	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90002532	MF-701
89-2772C	15:19504	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90003577	MF-236
89-2784	15:20816	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006446	MF-411
89-2867C	15:20099	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006810	MF-706; MF-742
89-2870C	15:19505	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006808	MF-700
89-2955C	15:19515	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005959	MF-235
89-2959C	15:20136	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005956	MF-706
89-3046C	15:19325	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006043	MF-721
89-3047C	15:19391	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006042	MF-721
89-3051	15:20237	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006367	MF-706
89-3069C	15:19392	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90005595	MF-814

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
SAND–					
89-3073	15:20238	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005823	MF-700
89-3135C	15:19950	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007213	MF-704
89-7019C	15:19393	NTIS, PC A03/MF A01; OSTI; INIS		DE90006047	MF-814
89-7087	15:19394	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006369	MF-721
89-7107	15:20999	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005825	MF-712
89-7153	15:20840	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006465	MF-405
89-7154	15:21000	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006751	MF-414
89-7155	15:20919	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006463	MF-712
89-8266	15:20137	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006370	MF-905; MF-906
90-0092C	15:20251	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006278	MF-706
90-0152C	15:19867	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007074	MF-704
90-0227C	15:21110	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007070	MF-705
90-0277C	15:20138	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006536	MF-712
90-0334C	15:20081	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007412	MF-706
90-0335C	15:20082	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007153	MF-706
90-0395	15:19868	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006373	MF-404
90-7010C	15:19395	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007562	MF-722
90-7028C	15:19185	Sandia National Laboratories, Technical Library-3140, Albuquerque, NM 87185			ND-108
90-8200	15:19951	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008112	MF-700
90-8205	15:19952	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006371	MF-704
90-8209	15:19237	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008113	MF-113; MF-102
SCIENTIFIC–					
1	15:20603	*See* AD-A–214203/2/XAB			
SCPRI-RM–					
1-1989	15:20310	NTIS (US Sales Only), PC A03/MF A01		DE90752540	
10-1988	15:20319	NTIS (US Sales Only), PC A03/MF A01		DE90752536	
10-1989	15:20320	NTIS (US Sales Only), PC A03/MF A01		DE90752543	
11-1988	15:20321	NTIS (US Sales Only), PC A03/MF A01		DE90752538	
12-1988	15:20322	NTIS (US Sales Only), PC A04/MF A01		DE90752539	
2-1989	15:20311	NTIS (US Sales Only), PC A03/MF A01		DE90752535	
3-1989	15:20312	NTIS (US Sales Only), PC A04/MF A01		DE90752534	
5-1989	15:20313	NTIS (US Sales Only), PC A03/MF A01		DE90752533	
6-1989	15:20314	NTIS (US Sales Only), PC A04/MF A01		DE90752532	
7-1989	15:20315	NTIS (US Sales Only), PC A03/MF A01		DE90752531	
8-1989	15:20316	NTIS (US Sales Only), PC A03/MF A01		DE90752542	
9-1988	15:20317	NTIS (US Sales Only), PC A04/MF A01		DE90752537	
9-1989	15:20318	NTIS (US Sales Only), PC A04/MF A01		DE90752541	
SERI/PR–					
212-3494	15:19869	NTIS, PC A12/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89009463	MF-270
SERI/STR–					
211-3612	15:19488	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000301	MF-273
232-3569	15:19461	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89009493	MF-271
SERI/TP–					
253-3614	15:19513	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000303	MF-235
254-3619	15:19507	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000308	MF-262
257-3662	15:19531	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000316	MF-261
SERI/TR–					
215-3513B	15:19479	NTIS, PC A18/MF A01 - OSTI		DE89009448	MF-233; MF-234
253-3438	15:19506	NTIS, PC A06/MF A01 - OSTI		DE90000311	MF-235
SFB-210/A–					
42	15:20323	Available from Karlsruhe Univ. (T.H.) (Germany, F.R.). Sonderforschungsbereich 210 Stroemungsmechanische Bemessungsgrundlagen fuer Bauwerke			
SINS–					
2050/P-2/PL/A	15:20619	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90616698	
2055/P-2/PL/A	15:20620	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90616699	
2063/P-6/PH/A	15:20699	NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS		DE90616982	
SLAC–					
356	15:20672	NTIS, PC A07/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008143	PC-414
SLAC-CN–					
375	15:20186	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007570	MF-414
SLAC-PUB–					
5035	15:20187	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006460	PC-414

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
5112	15:20188	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006458	PC-414
5119	15:20189	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006454	PC-414
5123	15:20209	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006452	PC-414
5135	15:20190	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006457	PC-414
5145	15:20673	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006461	PC-414
5161	15:20590	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006453	PC-414
5170	15:20783	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006455	PC-414
5183	15:20191	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006459	PC-414
5193	15:20784	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008100	PC-414
SLAC-TN–					
90-2	15:21111	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007569	MF-405
SNV–					
3597	15:20332	NTIS (US Sales Only), PC A05/MF A01		DE90748541	
SREL–					
37	15:20371	NTIS, PC A14/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006980	MF-702
ST–					
165/89	15:19436	*See* OEFZS–4499			
166/89	15:20206	*See* OEFZS–4500			
167/89	15:19437	*See* OEFZS-A–1444			
170/89	15:20364	*See* OEFZS-A–1499			
172/89	15:20365	*See* OEFZS-A–1526			
STEV-VIND–					
89-25	15:19532	NTIS (US Sales Only), PC A02/MF A01		DE90748567	
SVF–					
345	15:19199	Stiftelsen foer Vaermeteknisk Forskning, Stockholm (Sweden)			
TECHNICALPAPER–					
8812	15:20273	*See* PB–90-125675/XAB			
TR–					
29	15:19624	*See* AD-A–214045/7/XAB			
294	15:21088	*See* AD-A–214325/3/XAB			
7020-147-89	15:19768	*See* PB–90-129925/XAB			
TRI-PP–					
89-100	15:20193	NTIS (US Sales Only), PC A02/MF A01 - OSTI		DE90006881	
89-91	15:20156	NTIS (US Sales Only), PC A02/MF A01 - OSTI		DE90006883	
89-92	15:20192	NTIS (US Sales Only), PC A02/MF A01 - OSTI		DE90006882	
TTC–					
0938	15:20079	*See* SAND–89-2250C			
UCID–					
21199	15:20239	NTIS, PC A07/MF A01 - OSTI		DE90006327	MF-707
21362-OVERVIEW	15:19396	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006330	MF-804
21362-Vol.1	15:19397	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006335	MF-804
21362-Vol.2	15:19398	NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006358	MF-804
21362-Vol.3	15:19399	NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006359	MF-804
21362-Vol.4	15:19400	NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006360	MF-804
21362-Vol.5	15:19401	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006361	MF-804
21362-Vol.6	15:19402	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006362	MF-804
21362-Vol.7	15:19403	NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006363	MF-804
21362-Vol.8	15:19404	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006364	MF-804
21814	15:20785	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006357	
21824-Rev.1	15:20466	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006337	MF-706
21829	15:19614	NTIS, PC A07/MF A01; OSTI; INIS		DE90006356	MF-603
21835	15:20226	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008120	MF-706
21836	15:21001	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006355	MF-420
21844	15:20591	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006354	MF-706
21947	15:19953	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006353	MF-706
21950	15:20621	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007249	MF-700
UCLA/PPG–					
1253	15:21002	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006336	PC-421; PC-423
1256	15:21003	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006334	PC-420; PC-421; PC-423
UCRL–					
100232	15:20841	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006989	MF-706
100890	15:20194	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006990	MF-712
101123	15:20592	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007251	MF-700
101154	15:21005	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006987	
101472	15:20158	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006988	MF-706
101503	15:20334	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006923	MF-707
101516	15:21006	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007250	MF-700

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
101650	15:20140	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006773	MF-704
101720	15:20141	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007242	MF-706; MF-704
101782	15:21007	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006992	MF-420
101784	15:21008	NTIS, PC A02/MF A01; OSTI; INIS		DE90007283	MF-421
101793	15:21009	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007404	MF-410
101807	15:20786	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007252	
101922	15:19954	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90002972	MF-701
102284	15:19871	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006925	MF-704
102293	15:20734	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007248	MF-700
102585	15:19840	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006039	MF-706
102637	15:19872	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007259	MF-704
102651	15:20622	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007246	MF-700
102653	15:20252	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007241	MF-706
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TH Thailand
TN Tunisia
TO Tonga
TR Turkey
TT Trinidad and Tobago
TW Taiwan
TZ United Republic of Tanzania

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UG Uganda
US United States of America (USA)
UY Uruguay

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VE Venezuela
VI Virgin Islands of the United States
VN Viet Nam

WS Western Samoa

YD Democratic Yemen
YE Yemen
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